UNDP/GEF "*Development and Implementation of the Lake Peipsi/Chudskoe Basin Management Programme*"

PROPOSALS FOR COORDINATED MONITORING STRATEGY AND MONITORING PROGRAMME ON THE LAKE PEIPSI / CHUDSKOE OZERO

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1. INTRODUCTION

One of the most important objectives of the UNDP/GEF project "Development and Implementation of the Lake Peipsi/Chudskoe Basin Management Programme" is the preparation of the program for coordinated surface water monitoring in the two countries using United Nations European Economic Commission [UN ECE] guidelines for monitoring and assessment of transboundary lakes.

The most important basic document for efficient and sustainable use of transboundary water-courses and international lakes is The UN ECE Water Convention, which was drawn up under auspices of the Economic Commission for Europe, and adopted at Helsinki on 17 March 1992 (United Nations, 1992). Both riparian countries, either Estonian Republic or Russian Federation have ratified that convention. If some of the water experts in Russia have declared that the EC Water Framework Directive, 2000/60/EC was not binding for Russian Federation, so it was not the case with The Convention on the Protection and Use of Transboundary Water courses and International Lakes.

The Convention therefore addresses issues such as monitoring, assessment, warning systems, and the exchange and presentation of information. Parties bordering the same transbounday waters must set up joint or co-ordinated systems for monitoring, as well as joint or co-ordinated communication, warning and alarm systems. A primary objective of monitoring and assessment systems is to check that changes in the conditions of transboundary waters caused by human activity do not lead to any significant adverse effects on flora and fauna, human health and safety, soils, climatic conditions, heritage landscapes or physical structures, or the interaction between any of these factors.

The Global Environmental Facility under United Nations Development Programme [UNDP/GEF] has always been interested to support the activities of that Convention, and that was the main reason why for joint monitoring activities had been planned on the base of UN/ECE Guidelines on Monitoring and Assessment of Transboundary and International Lakes.

The common monitoring strategy has been under discussion several times in the Estonian Russian Joint Commission on Transboundary Water Bodies at the very beginning of the establishment of the Joint Commission. The harmonizing of the methodologies of sampling and analysis or investigations had been during last 6-7 years the main topic of discussions in the working group of water quality (former working group of monitoring and scientific investigations). Responsible persons of the Joint Commission have signed some agreements on harmonized monitoring programmes. Unfortunately the results of the monitoring events in Russia and Estonia are still incomparable because the differences in water chemistry analysis are too big, and the biological monitoring is still missing in Russia.

A very good estimation of the main shortcomings in the monitoring of the Lake Peipsi /Chudskoe was made by Mr. William Parr from Halcrow, Ltd., United Kingdom in the frame of Russian TACIS-project. Mr. Parr visited all Russian essential laboratories in the Lake Peipsi Basin. The report of findings was drafted in 2004, June. In the report he analyses monitoring of all waters, including rivers, lakes and groundwater bodies. His conclusions are discussed and mainly accepted by Estonian monitoring experts. A lot of these conclusions have been used in this report, commented and illustrated with Estonian/Russian parallel data of joint monitoring expeditions.

2. REQUIREMENTS OF WFD AND UN/ECE GUIDELINES

Water Framework Directive (2000/60/EC) defines the common principles of the Member States' efforts in § (23) as:

…to improve the protection of Community waters in terms of quantity and quality, to promote sustainable water use, to contribute to the control of transboundary water problems, to protect aquatic ecosystems, and terrestrial ecosystems and wetlands directly depending on them, and to safeguard and develop the potential uses of Community waters.

Monitoring is a very important component of each Water Management Plan and Nutrient Load Reduction Program. The co-ordination of the monitoring program and monitoring activities in the big transboundary lake like Lake Peipsi/Chudskoe is a hard and complicated work. The political, financial and other aspects must be taken there into account.

Integrated water management is primarily understood as a national level policy area. Integrated water management at the international level is usually not explicitly mentioned, and the local level is not always sufficiently taken into account. The situation is extremely complicated for the transboundary river basins located on the border of EU member countries or countries in accession, and the countries outsides EU.

Ten basic rules for development of the successful monitoring programme have been described in UN/ECE "Guidelines on Monitoring and Assessment of Transboundary Rivers", published by RIZA (Netherlands), March 2000, p. 47.

Ten basic rules for a successful monitoring and assessment programme:

1. The information needs must be defined first and the programme adapted to them, and not vice versa. Adequate financial support must then be obtained.
2. The type and nature of the water body must be fully understood, particularly the spatial and temporal variability within the whole water body.
3. The appropriate media (water, particulate matter, biota) must be chosen.
4. The parameters, type of samples, sampling frequency and station location must be chosen carefully with respect to the information needs.
5. The field equipment and laboratory facilities must be selected in relation to the information needs and not vice versa.
6. A complete and operational data treatment scheme must be established.
7. The monitoring of the quality of the aquatic environment must be coupled with

the appropriate hydrological monitoring.

8. The quality of data must be regularly checked through internal and external control.
9. The data should be given to decision makers not merely as a list of parameters and their values, but interpreted and assessed by experts with relevant recommendations for management action.
10. The programme must be evaluated periodically, especially if the general situation or any particular influence on the environment is changed, either naturally or by measures taken in the catchment area.

According to the assessment of national monitoring programs, along with the regularly conducted national monitoring activities, the following additional monitoring activities have to be organized in order to comply with the requirements of the UN ECE Guidelines:

- Benthic invertebrate fauna (In spring, April or at the beginning of May)
- Bottom sediments (thickness, content of nutrients, organic matter, heavy metals)
- Hazardous substances (PCB, PAH, pesticides)
- Monitoring of the Important Bird Areas (IBA) and another habitats in the catchment area of Lake Peipsi (Birds Directive, Habitats Directive)
- Monitoring of bathing water quality in the lake and rivers
- Fish monitoring (needs better harmonization and co-ordination)
- Coordination of joint monitoring activities, intercomparison tests and parallel samplings (one person in each countries is needed for better coordination)

3. PRACTICAL MONITORING ACTIVITIES TO IMPLEMENT UNDP/GEF PROJECT

If TACIS-project decided to support the delivering of modern equipment for Russian laboratories and trainings on sampling organizations, the UNDP/GEF-project concentrated the main interest to practical control of the use of the Guidelines on Monitoring and Assessment of Transboundary and International Lakes.

To implement UNDP/GEF project, the following activities had been carried out:

1. Comparative analysis of the national monitoring systems and systems of organization of monitoring in the two countries with aim to draft a report with the results of the analysis and proposals for changes needed in national monitoring programs to comply with the UN ECE Guidelines and organization of joint expeditions on the Narva Reservoir and Lake Peipsi.

This work had to be conducted by one Estonian expert and one Russian expert. The responsible Russian expert was not nominated. Several experts participated in the discussions from Russian Federation, as Ms. Svetlana Basova from Rosgidromet, Ms. Alla Sedova from Neva-Ladoga Basin Administration and others, however their opinions have sometimes been quite different.

2. The joint summer expedition (2003) had been organised on Lake Peipsi/Pskovskoe ozero and Narva Reservoir. Biological and water chemistry sampling had been organised by Russian and Estonian experts in sampling stations on the whole lake. Taking in account that biological sampling is not a part of the Russian State Monitoring program, the samples of phytoplankton, zooplankton, bacteria and benthic invertebrates had been collected in 2003 by Estonian experts only.

3. Two joint monitoring winter expeditions, financed by UNDP/GEF project and partially by TACIS project has been organised in March 2003 and in March 2004. The sampling according the full monitoring programme, including water chemistry, biological sampling, sediments was performed in all Estonian sampling stations by Estonian experts only. Sampling for water quality monitoring has been organised on the Narva Reservoir, but not on the Lake Peipsi/Pskovskoe by Russian experts.

4. The analysis of the results of those expeditions have been presented either Estonian and Russian experts in the meetings of the Joint Commission and in the meetings of working group for water quality and monitoring. The experts from TACIS- project, as Ms. Anne Roux (France), Mr. William Parr (United Kingdom), Mr. Mikko Jokinen and Mr. Lasse Koivunen have also participated in those meetings.

4. DISCUSSION ON COMPARISON OF ESTONIAN AND RUSSIAN NATIONAL MONITORING SYSTEMS WITH UN/ECE GUIDELINES

Comparison of the Estonian and Russian National Monitoring Systems with UN/ECE Guidelines is presented in 3 tables in appendix of this report. Those tables have been sent for discussion to Russian monitoring experts in January 2004. Unfortunately we haven't got any response from Russian monitoring experts.

The Water Framework Directive requires EU Member States to monitor

- Benthic invertebrates;
- Fish;
- Phytoplankton;
- Macrophytes and phytobenthos.

Those extremely important biological parameters are not included into Russian State Monitoring program. They are beyond of the interests of RosGidromet, the main responsible institution on monitoring activities in Russia. The investigations carried out by scientific institutes are not coordinated very well with water chemistry monitoring, and the data is fragmentary and not used very much for estimation of the state of the lake. The profound study of the differences and shortcomings of the National Monitoring programs in Russia and Estonia was carried out by Mr William Parr. TACIS project outcomes with UNDP/GEF project remarks are listed below.

Compared with water monitoring programs in EU member states, the system currently used in Russia suffers from the following problems:

- **Monitoring is carried out at too few sites and monitoring frequencies are not great enough, particularly for instream load assessment.**

- **The existing monitoring network is unrepresentative**, e.g. only Chudskpoye/Pskovskoye/Teploye lakes and Narva Reservoir are monitored, even though **there are approximately 2,500 smaller lakes within the Russian catchment of the major lakes, none of these are currently monitored for water or ecological quality.** Similarly, scant attention is paid to monitoring of groundwater quality and groundwater level.

- **Information is fragmentary and of different types**. Not all sites are monitored on a routine basis – some have not been monitored for several years, and different organizations utilize different sampling/analytical procedures for the same chemical monitoring.

- **The comparison of the chemical analyse procedures in the Estonian and Russian laboratories** participating in the monitoring of the Lake Peipsi/Chudskoe **has demonstrated big differences**. Estonia harmonized the methodologies with standards used in EU. The laboratories in Estonia have been provided with modern equipment like autoanalyzers, ion-chromatographs, mass-spectrometers, atomic-absorption spectrophotometers, etc. during last ten years. The quality assurance and internal control is implemented in all laboratories, and they participate in several international intercalibrations. The main laboratories have international accreditation. Unfortunately development in Russian laboratories was not so fast.

- Monitoring of point source discharges is undertaken, but **assessment of diffuse sources of pollution (including nutrients) is not adequately considered in the existing monitoring programs.**

- **The existing system for assessment of water quality is too complex and does not consider ecological impact.**

- **Data interpretation/assessment is poor.** Standard procedures do not appear to exist and there is little if any guidance offered on statistical techniques from which to develop improved monitoring programs/procedures. The most problematic situation is in water quality monitoring. There are big differences in phosphorus analysis among the laboratories, participated in the analysis of water samples. In the analyse results of last summer joint expedition are sometimes differences 2-3 times. Instead of total nitrogen (TN or N_{TOT}), TIN (total inorganic nitrogen, or the sum of NH_4^+, $NO_2^-$and NO_3^-) is still used in Russia. The performed intercomparison tests have not given the expected results.

- There is a lack of collaboration between different organizations involved in water quality/ecological monitoring, so data is not stored within a single database or location.

- **The main water monitoring organizations have relatively little experience of biological monitoring**. This should be at least as important as chemical monitoring (and potentially cheaper, since monitoring frequencies are much lower), but the benefits and results are difficult for many non-biologists to understand (even specialists who are only used to dealing with chemical data). Thus, biological monitoring data may be viewed as non-conclusive or unreliable. Even for those organizations involved with biological monitoring, there is a basic lack of understanding about the development of biological indices.
  In 2003 Ms. Marina Melnik from GosNIORKH took biological samples from Russian sampling stations. She also participated in the several practical trainings in the Netherlands and in Estonia (In Võrtsjärv Limnological Station). <u>Some of those components of biological monitoring would be probably included into Russian State Monitoring Program.</u>

- **Perhaps most importantly, however, there is insufficient funding of operational and capital expenditure**. Institutional changes have attempted to address this issue by requiring some organizations/laboratories to operate on a more commercial basis, but there is only a limited market within Russia and environmental issues are not regarded with the same level of importance as in EU member states. This has meant that funding for monitoring equipment is effectively zero. In order to gain extra funding for monitoring, organizations, therefore, sell their data to each other and are less inclined to cooperate their monitoring activities. This is a 'solution' to the funding crisis, which although understandable, nevertheless promotes a lack of cooperation and continues the downward spiral, since the different organizations cannot afford to buy data from each other.

- **No forum currently exists within Russia for the institute to discuss environmental problems of the lake with officials or politicians, and this is seen as a major reason for poor funding of environmental monitoring**. The linking of good environmental status with a stable, wealthier local economy (as a result of eco-tourism, sustainable fisheries, etc.) is seen as a step towards improved funding of environmental management (including monitoring).

- **The collection, storage and use of environmental monitoring data is not regarded as a priority by those organizations which are not themselves actively involved in monitoring. Nevertheless, monitoring is required to measure the status of waters, terrestrial habitats, communities and species, and thus to direct capital investment programs.** While it is usually different organizations responsible for capital investment (and maintenance funding) and monitoring, the selection of investment priorities (e.g. in terms of waste management) is dependent upon monitoring data.

  However, financing of future monitoring data collection by selling the data once it has been collected is an inappropriate and short-term solution that offers little hope for sustainable monitoring. For many decisions (e.g. the selection of appropriate nutrient reduction techniques) data covering a period of at least 5 years is required, without which the risk of selecting incorrect or inappropriate capital investments increases. If data is not available to cover this time period, it cannot be collected by subsequently increasing monitoring frequency, e.g. to weekly rather than monthly sampling if funding can be made available.

Data storage and availability is a very real problem. The sale of data by organizations, while used as a fund-raising strategy, inhibits the flow of data between those organizations. In addition, the transfer of data as hard (paper) copy, rather than in an electronic format, means that there is additional scope for typographic errors being entered into datasets when the data is transferred. Data should be entered onto an electronic database as soon as possible after collection, should be checked (quality assured) by those analysts who are responsible for measuring the data and this should be used as the reference data source for those determinations.

- **Assessment, quality assurance proceedings, presentation of the monitoring results digitally, and cooperation between laboratories and institutions involved in monitoring activities are needed.** See as a bad example the table of parallel results of winter monitoring, 2004**.**

- **Different sampling methodologies are used by different organizations, which present a problem both in terms of being able to compare data from different laboratories within Russia, and with being able to compare Russian and Estonian water quality data.** Vodkhoz laboratories are accredited to undertake analysis using Russian Goststandart methodologies, which specify requirements for particular types of analytical equipment and for particular reference standards against which the equipment is to be calibrated. Any results that are greater than the maximum calibration standard or lower than the minimum calibration standard are not officially recorded. This may not appear to be such a problem, but for natural waters the analytical range for phosphate is 0.05-1.0 mg PO_4 l^{-1} and for total phosphorus the range is 0.02-0.4 mg P l^{-1}.

  In EU countries, the limit of detection for phosphorus is more typically 0.003-0.01 mg P l^{-1}, with the OECD fixed boundary system for the classifying the trophic status of lakes having boundaries at 0.005 mg TP l^{-1} (ultra-oligotrophic/oligotrophic boundary), 0.01 mg TP l^{-1} (oligotrophic/mesotrophic boundary) and 0.035 mg TP l^{-1} (mesotrophic/eutrophic boundary). Thus, all oligotrophic and many mesotrophic Russian lakes would be classed as being below the limit of detection. At the other extreme, for wastewaters the Gosstandart analytical range is 0.04-6.0 mg TP l^{-1}, but total phosphorus concentrations in raw sewage are more typically in the region of 10.0 mg TP l^{-1}. In treated effluent from a well-maintained sewage treatment works (including primary sedimentation and biological treatment, but not including tertiary P-stripping), a total phosphorus concentration of 7 mg l^{-1} may be considered typical.

Although it is unlikely that phosphorus levels in many Russian rivers would be as high as those occurring in some lowland UK rivers, 0.4 mg TP l^{-1} as the maximum analytical limit simply would not be high enough for routine monitoring purposes. For example, the average annual phosphorus concentration in the River Thames is about 1 mg l^{-1}.

However, the phosphorus concentrations in those rivers for which we have data appear to be low in a Western European context – low to the point that it is difficult to understand why the catchment has been identified as having a particular eutrophication problem!

- The monitoring of hazardous substances has mentioned by Russian experts as the activity of high importance because those substances are crucial in biotoxicity, which is the basic component in the classification of water bodies in Russia. Unfortunately the toxic substances for monitoring programme are different in Russia and in Estonia. The heavy metals and pesticides, like DDT, DDE, α-HCCH, γ-HHC, etc. are in focus in Russia. The monitoring of PCB-s, PAH-s and more modern pesticides are recommended in the UN/ECE "Guidelines…" **It will be very difficult to compare the monitoring results, if the parameters are different.**

- **And so it becomes clear that in terms of trophic status and phosphorus source apportionment monitoring, there could be problems with the use of goststandards.** Other problems appear when it is realized that Vodkhoz, who are responsible for calculating discharge consents and monitoring compliance against these consents, as well as the quality of water 500 m upstream and downstream of major discharges, use different methodologies to Hydromet. These organizations also use some different methods to those of Estonian environmental monitoring organizations.

- The issue of what to do with data values below the limit of detection (<LoD) needs addressing. At present when a data value is <LoD, it is recorded as 0, which in the case of toxicants, major ions and nutrients, gives an over-optimistic impression of water quality, but in the case of dissolved oxygen, this is more likely to lead to a pessimistic view of water quality. When values of <LoD are obtained, they should be recorded as such, with the limit of detection specified. When calculating summary statistics or undertaking statistical analysis of results, it is usual to replace values of <LoD with LoD/2. This will not often make a large difference to summary statistics where variability is high and the LoD is set at an appropriately low level, e.g. Table 1.1.

Table 1.1 Summary statistics for Pskov Hydromet phosphate monitoring data (mg l^{-1}) for the Velikaya River downstream of Pskov (1999-2002)

Statistic	Values <LoD = LoD/2 = 0.005 mg l^{-1}	Values of <LoD = 0
number	25	25
mean	0.035	0.034
median	0.010	0.010
80%ile	0.044	0.044
20%ile	0.005	0.000

These results also highlight an additional problem – although samples are collected on each sampling occasion, these samples are not analyzed for all parameters. Here, during the period 1999-2002, 47 sampling trips were made, but phosphorus was measured on only 25 of these occasions.

- **The clear understanding of the Russian laboratories, which have to be equipped with modern equipment and chemicals in Lake Peipsi/Chudskoe region should be worked out.**

5. DISCUSSION ON RESULTS OF WINTER MONITORING DATA

The monitoring of the **chemical** and **ecological status** of the lake, as well as **oxygenation conditions,** and **monitoring of sediments** was carried out in April, 2003 in Estonian part of the lake only, and on the whole lake in March, 2004. The monitoring has been organized by Estonian experts together with Russian experts, using the same sampling methodology, which had been harmonized with UN/ECE Guidelines on Monitoring and Assessment of Transboundary and International Lakes. The monitoring costs had been covered by UNDP/GEF project "Development and Implementation of the Lake Peipsi Basin Management Program". The monitoring activities have been coordinated by senior researcher Ms. Kylli Kangur from the Institute of Zoology and Botany at Agricultural University of Estonia and coordinated with Russian expert by Mr. Ago Jaani, secretary of the Estonian-Russian Joint Commission of Transboundary Water Bodies. The joint winter monitoring was in the work-plan of the working group for monitoring and scientific investigations of the joint commission 2004-2006.

The results of the Winter Monitoring 2003 and 2004 were the topic of discussion during the joint meetings of Estonian and Russian experts on December15 2003 and June 16 2004 in Tartu, Estonia). The final conclusions are repeated in this report again. They help to stress on the importance of harmonized methods in the whole monitoring program, and for biological monitoring respectively.

The analysis of the water chemistry, biota and bottom sediments in Lake Peipsi in spring-winter 2004 reached following conclusions:

1. The alkalinity, also the content of calcium in the water of L. Peipsi is higher in winter than in summer.
2. A comparison of oxygen content from March 2003 and March 2004 to the 2002 sampling data shows that winter oxygen level in L. Peipsi has decreased. Release of Fe-bound phosphorus from bottom sediments may occur when anoxic conditions prevail near bottom layer of water, and water pH increases over 8, as it appeared in several stations in March 2004.
3. The north-south polarity of the lake in respect to nutrients has enlarged due to the increase in content of biogenic elements, especially the content of phosphorus compounds in L. Lämmijärv and L. Pihkva during last years, according to both summer and winter samplings.
4. The content of phosphate ions in the Velikaya River was over 8 times higher, compared to the same ions content in Emajõgi River mouth. Those data show the efficiency of the Tartu water treatment plant.
5. In March 2004, the content of orthophosphate ions has increased, compared to data from March 2003, at every comparable sampling station, both in the surface and near bottom water.
6. As for the total nitrogen content, the quality of water of L. Lämmijärv and L. Pihkva is bad according to the summer and winter data.
7. The reason for the high content of ammonium ions at the stations near the Velikaya River might have been the oxygen deficit.
8. Up to two times higher concentrations of phosphates in the near bottom layer when compared to surface water indicates the release of orthophosphates from bottom sediment that is caused by anaerobic conditions in the bottom layer water. This difference was even bigger (4.5 times) after cold and long winter 2003.
9. The content of total phosphorus in bottom sediments in March 2004 was usually over 1100 mg P per kg dry solid matter, the highest values of this parameter were measured in L. Pihkva (up to 1600 mg P per kg dry matter).
10. The sediment studies of L. Peipsi demonstrated that the content of total phosphorus, as well as phophorus fractions is region-wise different.
11. Comparison of bottom sediments rich in organic matter shows that the content of total phosphorus (1100-1600 mg P per kg dry matter) in surface sediment of L. Peipsi was even higher than in L. Võrtsjärv, where according to Kisand (2002) the same parameter values were in average 1000 mg P per kg dry matter.
12. The proportion of loosely bound phosphorus in total phosphorus content was 1-2% that is higher than according to *Boström et al (1988)* usually in the lakes (less than 1% of sediment total phosphorus). The highest content of loosely bound phosphorus was determined near Mustvee, where the content of total phosphorus and other phosphorus fractions per sediment dry matter was the highest. Fe- and Al-bound phosphorus percentage was approximately the same (32-35%) in all the sampling stations. The share of Ca-bound phosphorus was the highest in L.Lämmijärv (45%) and in L. Pihkva (44%).
13. The content of total nitrogen in sediments was higher in winter than during the vegetation period.

14. In March 2004, the abundance of phyto- as well as zooplankton was low, compared to characteristical data in wintertime.
15. The share of cyanobacteria in phytoplankton was higher in March 2004 than in previous studied years (1999, 2002 and 2003), the rise in biomass is evident in 2003 and 2004.
16. Throughout four years of studies the amount of phytoplankton biomass as well as chlorophyll *a* content in L.Peipsi s.s. were higher than in the southern parts of the lake. This cannot be associated with the amount of nutrients in the water – in winter the limiting factor for the phytoplankton is the light, instead.
17. The abundance of zooplankton had ceased in L. Peipsi s.s. especially in the L. Lämmijärv in winter 2004 when compared to previous winters. The missing zooplankton at the Velikaya River mouth, where oxygen deficit and high content of ammonium ions occurred, is outstanding.
18. The total count of bacteria in surface water as well as in integral water in March 2004 was low ($< 3 \times 10^6$ cells ml^{-1}), also the plate count of saprobic bacteria from integral water was at low level (< 700 cells ml^{-1}). The highest content of saprobic bacteria was studied at the Velikaya River.
19. The spring-winter studies on L. Peipsi are necessary to assess the ecosystem as a whole during the critical period before the ice break. Due to long water residence time, the release of phosphorus from sediments may influence the growth of algae during vegetation period.

In addition to the summer data, the 2004 winter studies of southern parts of Lake Peipsi affirmed that the pollution through Velikaya River contributes the most to the degradation of ecological state of L. Peipsi, which cannot be related to the benign weather conditions for the phytoplankton, like it was the case in summer.

NB! See also the appendix 4, with table of comparative results of water chemistry monitoring.

6. RECOMMENDATIONS

To relay on the analysis of the above- mentioned meetings and practical experiences of the joint expeditions as well as the requirements of EU Water Convention and EC Water Framework Directive the following proposals for coordinated monitoring strategy and programme have been compiled and presented hereby. The monitoring strategy worked out by TACIS- project is a long-term strategy for next 15-20 years. The implementation of that strategy needs very big investments, and several new monitoring activities, not performed in Russia jet. UNDP/GEF project proposes short-term monitoring programme to coordinated monitoring activated for next 5 years.

6.1. LONG-TERM MONITORING STRATEGY

Recommended monitoring parameters are in chapter 6.2 in the Mr Parr's report. They are relevant for euthrophic big lakes like Peipsi/Chudskoe. Keeping in mind the importance of diatoms communities and Al and Fe compounds with phosphorus in sediments, the monitoring of Si, Al and Fe would be also included into monitoring program. In general the recommended parameters are similar to those, which are listed in UN/ECE and EU monitoring guidelines.

6.1.1. Large lakes: Peipsi/Chudskoe-Pskovskoe and Narva Reservoir

The parameters chosen for monitoring the lake water column are similar to those selected for rivers, except for nutrients, where total N and total P are selected instead of the dissolved nutrient fractions and Secchi depth is monitored instead of suspended solids (Section 6.2.1). However, for large lakes, much greater emphasis is placed on monitoring sediment quality, than in rivers where the sediment is subjected to much more turbulent mixing.

6.1.2. Water column

- Dissolved oxygen
- Temperature
- pH
- Conductivity
- BOD
- COD
- Total Nitrogen
- Total phosphorus
- Oxidised nitrogen
- Ammonia
- Secchi depth
- Colour
- Hardness
- Copper
- Zinc
- Lead

6.1.3. Sediment

A decision has to be made as whether only in surface sediments or whether only the surface of sediment cores should be analyzed, or whether cores should be divided into layers and each of these analyzed separately to indicate how pollutant loads to the lake(s) had changed over time. At present it is recommended that only surface sediments should be analyzed since historical pollutant loads, while important to understand, are best considered as a research activity, and not part of a routine monitoring program. A monitoring frequency of once every 5 years is considered adequate for sediment quality. The following parameters should be monitored in surface sediments as part of a 5-yearly survey (i.e. all sites monitored during the same year) at the same sites at which water quality is monitored:

- Heavy metals – Hg, Cd, Cu, Zn, Pb, Fe, Cr, Mn.

- Phosphorus – total phosphorus as an indicator of phosphorus enrichment. However, the results cannot be used to indicate the likely extent of phosphorus release or recovery of sediment due to the reduction in phosphorus loads to the lake(s) during the 1990s. This is best monitored by measuring the equilibrium phosphorus coefficient (EPC_0), a much more expensive and time-consuming parameter to monitor. Again, this latter parameter is best monitored as part of a research program, than a routine monitoring program.
- Particle size analysis – necessary to understand the extent of contamination, since smaller particles have a larger surface area/volume ratio, so can adsorb greater amount of pollutants.
- Organic content – an important indicator of the trophic status of sediments, and a key factor influencing the extent of organic micropollutant enrichment.
- Dry weight – since sediment pollutant 'concentrations' are described in terms of amount of pollutant/sediment dry mass.
- Organic micro-pollutants – no specific parameters were decided upon, but it was acknowledged that many of the WFD priority pollutants fell into this category, requiring very expensive specialist equipment and very highly trained analytical staff. For this reason, the Estonians have decided not to undertake such analyses themselves, but have contracted the work to a laboratory in another country. As such, those organic micropollutants that would be monitored would be restricted to those that were currently monitored (in water samples) by Hydromet.

6.1.4. Biological monitoring

Biological monitoring holds a number of advantages over discrete chemical monitoring:

- Much lower sampling frequencies are required, since biological communities effectively offer a composite indicator of water quality. For example, benthic macroinvertebrates monitoring represents water quality over the previous year, while benthic diatom monitoring represents water quality over the previous month (**diatom** communities have more rapid regeneration times than macroinvertebrates following episodic pollution events).
- Biological monitoring results are indicative of 'worst case' water quality during the previous regeneration period of whichever biota are monitored.
- Biological monitoring provides a direct measure of the effects of water quality on aquatic ecology. This is particularly useful where natural levels of some toxic compounds (e.g. heavy metals) are elevated, since biota tend to 'acclimatize' to higher sub-lethal levels of pollutants over long periods of time. "

TACIS-report is very radical and solid but it is hardly possible to implement all those recommendations in following 5-10 years in Russia. Maybe it's not necessary on the whole territory of Russian Federation. **Some harmonization of the monitoring parameters, analytical methods and in data reporting and exchange routines is indispensable in transboundary water bodies.**

6.2. PROPOSALS FOR SHORT-TERM MONITORING PROGRAMME WITH AIM TO CO-ORDINATED MONITORING ACTIVITIES

The short-term monitoring program, presented in following table, needs not so much changes of existing monitoring programs in Russia. An additional financial support from Russian government and from international organisations is needed, of course but those investments are not so big.

Surveillance monitoring of the physico-chemical quality elements: • transparency [Secchi disc m]; • water colour [Pt units]; • dissolved oxygen in vertical series (summer and winter) [mgO_2/l]; • temperature [t ^{0}C]; • acidification [pH], alkalinity [HCO_3^- mg/l]. Ca^{2+}, Mg^{2+}, Na^+, K^+ and Al^{n+}, Fe are useful also; • nutrient conditions: Total P, P_2O_4 (SRP), Total N, NO_3^-N, NO_2^-N, NH_4^+N [mg/l] ***Remark: Standardisation of analytical techniques between laboratories is needed***
Surveillance monitoring of the biological quality elements: • macrophytes (composition and abundance); • benthic invertebrates (composition, abundance, sensitive species); • fish (composition, abundance, sensitive species); • phytoplankton (composition, abundance, biomass Chla, blooms); • phytobentos* (composition and abundance); • periphyton* – a complex community of microbiota (algae, bacteria, fungi, animals and organic detritus) that is attached to substrata.
Monitoring of the hydromorphological quality elements: • quantity and dynamics of water flow (inflow and outflow rates, mixing and circulation patterns; • residence time (volume, depth, inflow and outflow); • water level variation (lake surface, lake volume, lake depth); • quantity, structure and substrate of the lake bed (grain size, sedimentation rate, sediment age (Cs 137), microfossils in paleolimnologicgal studies*; • structure of lake shore* (length, riparian vegetation cower, species present, bank features and composition)

Remarks: *quality elements with *might by beyond of short-term monitoring programme*

7. CONCLUSIONS

To implement UNDP/GEF project, the following activities had been carried out:
1. Comparative analysis of the national monitoring systems and systems of organization of monitoring in the two countries;

2. The joint expedition (summer 2003) on Lake Peipsi/Pskovskoe ozero and Narva Reservoir;
3. Two joint monitoring winter expeditions in March 2003 and in March 2004;
4. Meetings to analyze and present results of those expeditions for Estonian and Russian experts and members of the working group for water quality and monitoring of the Joint Commission.

All monitoring routines and essential monitoring parameters described in report are in EU WFD and UN/ECE "Guidelines on Monitoring and Assessment of Transboundary and International Lakes" In draft form they are in three tables, which are also in appendix of this report. Two last rows illustrate, which of those are in the State Monitoring Program either in Estonia or Russian Federation. The last, fourth table illustrates the results of the joint winter monitoring on Lake Peipsi.

Result of the analyses of efficiency of joint monitoring activities on Lake Peipsi/Chudskoe ozero made by monitoring experts of TACIS project and UNDP/GEF project are presented in chapter 4. Long-term monitoring strategy and short-term monitoring programme are proposed in chapter 6.

UNDP/GEF project mid-term evaluation experts pointed out also that agreement on Water Quality Status between Russia and Estonia is a potentially serious issue that could lead to the failure of an agreement of a joint management programme for the lake. The problem stems from the differing approaches to monitoring (specifically, sampling and analysis) of water in Russia and Estonia. Whilst there have been two joint monitoring programmes there are believed to be still differing conclusions on the results. The impact of this is the interpretation of the water quality in the lake varying between 'good' and 'moderate', which has an impact on the level of measures that are needed to improve the situation in Russia and Estonia. To resolve this situation the following **recommendations** are made (these are not necessarily the responsibility of the UNDP/GEF project, but the project is urged to suggest these as urgent recommendations to the Russian/Estonian authorities):

- Agreement is needed on **comparable** monitoring systems. This does not imply the need to use identical methods, but they need to be sufficient confidence that the data provided is comparable. This can be achieved by strict testing of the analytical methods ('performance' testing), the introduction of a recognized system of analytical quality control, and the participation of all laboratories in inter-laboratory check-sample tests. In addition to the analytical agreement needed, there should also be comparability in sampling methods.
- Monitoring should be extended to include biological parameters (this is a requirement for Estonia under the WFD).
- Data collected from the lake (and key tributaries) should be shared as soon as possible after validation.

The most important obstacle for coordinated monitoring program is the lack of good will. A lot of international experts analyzed the situation and made many good

recommendations. Those topics have been discussed in several meetings, and the financial support has been remarkable. The atmosphere of those meetings was however not always constructive, and the results of the joint expeditions have been quite miserable.

A P P E N D I X

Content:

Table 1. Key features of hydromorphological quality elements for lakes

Aspect/feature	Quantity and dynamics of water flow	Residence time	Connection to the groundwater body	Lake depth variation (water level variation)	Quantity, structure and substrate of lake bed	Structure of lake shore
Measured parameters indicative of QE	Inflow and outflow rates, water level, spillway and bottom outlets, discharges, mixing and circulation patterns	Volume, depth, inflow and outflow	Lake surface, lake volume	Lake surface, lake volume, lake depth	Grain size, water content, density, LOI, elemental composition, sedimentation rate, sediment age (Cs 137), microfossils	Length, riparian vegetation cover, species present, bank features and composition
Pressures to which QE responds	Climate variability, flood control, man made activities	Climate variability, man made activities	Climate variability, man made activities	Climate variability, siltation water use, flow discharges	Siltation	Man-made modifications, erosion, run-off. Water level fluctuations in reservoirs
Sampling methodology	Water level gauge, flow meters and current meters. In situ us-ing scales or submersible pro-bes associated or not to teletransmission.	Echo sounding neces-sary for depth- volume curves, hypsographic curves.	Depth-volume curves, hypsographic curves. Water level gauge.	Sonar device (echo-sounder Phathometer, transect methodology with metered sounding poles.	Core and grab samplers de-pending on study objectives 3 main sampling types: deterministic, stochastic and regular grid systems	Transects, aerial photogra-phy, planimetry
Typical sampling frequency	Weekly/monthly. Hourly/daily (reservoirs)	Every 5/10 years. Once per year for reservoirs	Variable	Natural lakes:every 15 yrs. Reservoirs: variable	Mostly once a year, or less frq. If no changes expected, in polluted lakes every 3rd or 5th year	Every 6 years
Time of sampling	All seasons	All seasons, except of the ice-cover period	All seasons	Reservoirs: generally du-ring operational functio-nning, spring/begin fall	Usually winter (in Nordic countries from ice)/summer	Spring/summer during growing period
Typical “sample” size or survey area	Inflowing/outflowing waters, gauging stations	Entire lake	Entire lake	Entire lake	Varied depending on study objective	Entire lake shore habitat
Ease of sampling/ measurements	Simple following min. training	Easy for theoretical, dif-ficult for effective R.T.	Difficult	Relatively easy following minimal training	Relatively easy following minimal practical training	
Current use in monitoring programmes or for classi- **Fication in EU**	No/yes (reservoirs)	No	No	No, France, UK, Spain	No	No
Current use in monitoring programme in Estonia	70-75% of rivers with gauging stations and flow measurement	No	No	Yes	No	No
Current use in monitoring programme in Russian Federation	Four main inlets only have gauging stations	No	No	Yes	No	No

Table 2 Key features of the chemical and physico-chemical quality elements for lakes

Aspect/feature	Transparency	Thermal conditions	Oxygenation conditions	Salinity	Acidification	Nutrients
Measured parameters indicative of QE	Secchi depth, turbidity, colour, TSS	Temperature	DO, TOC, BOD, COD, DOC	Conductivity	Alkalinity, pH, ANC	Total P, SRP, Total N, N- NO_3, N- NO_2, N- NH_4
Relevance of quality element	Eutrophication, acidification	Hydrological cycle, bio-Logical activity	Production, respiration, mineralisation		Buffering capacity, sensi-tivity to acidification	Eutrophication
Pressure to which QE responds	Agricultural, domestic and industrial discharges	Thermal discharges. Water management in reservoirs	Eutrophication, organic pollution, industr. discharge	Industrial discharges, run-off	Acid rain, industrial discharges	Agricultural, domestic and industrial discharges
Sampling methodology	*In situ* using Secchi disk TSS: field sample collect-ion followed by lab. analysis Turbidity: *In situ* turbiditi meters, nephelometers	*In situ* using thermistor probes or reversing type Hg thermometer	*In situ* submersible probes; field sample collection followed by laboratory Winkler titration	*In situ* using submersible probes	*In situ* measurement of pH with probe. Sample collection followed by laboratory analysis	Sample collection in the field followed by laboratory analysis
Typical sampling frequency	Monthly/quaterly. Forthnightly or monthly du-ring growth season in Nordic countries.	Monthly/quaterly	Depends on morpho-logical characteristics of lake: daily/monthly or at the end of stratif. periods (late winter if ice cover) or late summer.	Monthly/quaterly. Should be measured during snow melt or heavy rainfall events.	Monthly/quaterly. Should be measured during snow melt or heavy rainfall events.	Monthly/quaterly. Fort-nightly or monthly during growth seasons in Nordic countries.
Time of year of sampling	All seasons	All seasons	All seasons	All seasons	All seasons	All seasons, or mainly du ring growth season, SRP measured during late winter in bottom waters
Typical "sample" size	*In situ* observations. Samples for chemical analysis (turbidity, TSS)	Water column profile	Single measurements, water column profiles, 100 ml for Winkler titration	*In-situ* water column profile, integrated epilimnion or single sample from outlet	Single sample from outlet of lake or water column profile.	Integrated epilimnion, single samples in water column profile (100-500ml)
Ease of sampling/ measurements	Simple	Simple	Simple	Simple	Simple	Relatively easy, depth sampler need for deep lakes
Current use in monitoring progr. or for classification	Yes	Finland, France, Italy, Norway	Finland, France, Italy, Norway, Sweden	Belgium, Finland, France, Italy	Belgium, Finland, France, Italy, Norway, Sweden, UK	Finland, France, Ireland, Italy, Germany, Norway, Spain, Sweden, UK, Netherlands
Current use in monitoring progr, or for classification in Estonia	Yes	Yes	BOD7, $COD_{Mn;CR}$; DO and DOC not regularly in different water layers	Yes	Yes	Yes,
Current use in monitoring progr, or for classification in Russian Federation	Yes	Yes	BOD5, $COD_{Mn;CR}$; DO and DOC not regularly in different water layers	Yes	Yes	Total N not measured but calculated

Table 3 Key features of each biological quality element for lakes

Aspect/feature	Phytoplankton	Macrophytes	Phytobenthos	Benthic invertebrates	Fish
Monitored parameters indicative of QE	Composition, abundance, biomass, (Chla), blooms	Composition and abundance	Composition and abundance	Composition and abundance, diver-sity and sensitive taxa	Composition, abundance, sensitive species, age struct.
Pressures to which QE responds	Eutrophication, organic pollution, acidification, toxic contamination	Eutrophication, acidification, toxic contamination, siltation, river regulation, lake water level, introduction of exotic species	Eutrophication, organic pollution, acidification, toxic contamination, sil-tation, lake water level, introduction of exotic species	Eutrophication, organic pollution, acidification, toxic contamination, siltation, river regulation, hydro-morphological alteratrion (littoral)	Eutrophication, organic pollut-ion, acidification, toxic contami-nation, fisheries, hydromorpho-logical alteration, introduction of exotic species
Sampling methodology	Integrated or discrete samples in the water column, 1-5 sites per lake. A number of sampling gear are commonly used such as hand-held bottles or flexible hose	Aeral photography or/and transect sampling perpendicular to the shore line	*In situ* observations of occurrence of natural substrate in littoral zone and/or among macrophyte beds as well as scraping of substrata	Qualitative or semi-quantitative hand net or kick-sampling; Ekman grab or core sampling. Grab type depends on type of sub-strate, *e.g.* submerged aquatic veg. -dip net; sand and clay-Peterson, Van Veen grabs; mud- Ponar, Ekman grabs	Electrofishing. Net captures, several types (*e.g.* gill nets, trammel net) Trawls Acoustic
Habitats sampled	Water column (i.e. epilimnion, euphotic zone, metalimnion)	Macrophytes: littoral area	Benthic substrat/ artificial substrata	Littoral, sub- littoral and profundal	Littoral, open waters
Typical sampling frequency	Monthly/quaterly In Nordic countries 6 times/summer	Yearly (late summer in Nordic co-untries), in natural lakes every 3-6 years	Varied from several times during the growing season to once a year	Yearly, in natural lakes every 3 – 6 years. Twice yearly in littoral	Depends upon water body phy-sical characteristics and objective, yearly
Time of year of sampling	All seasons. No sampling during ice coverage.	Late summer, decided through expert judgement	Quaterly/6 monthly/ several times du-ring the growth season. No sampling during ice coverage (Nordic countries)	Early spring and late summer	Late spring through to early autumn
Laboratory or field measurement	Laboratory sample preparation fol-lowed by identification, counting and biomass determination under microscope. Chla and algal toxin determination in laboratory	Field measurements trough aerial photography; samples from tran-sects, lab. identification to species; analysis of Chl-a content, fresh, dry and ash free dry biomass, org. cont.		Sample processing in the laboratory at least 100 organisms per sub-sample (if possible) are identified to the appropriate taxonomic level frequently to species	Sampling duration and area are recorded. In the lab the specimens are iden tified to the species, enumerated, measured and weighted
Current use in biological monitoring or classificat-ion in EU	Denmark, Finland, Ireland, Nether-Lands, Sweden, UK and Norway	Denmark, Netherlands, Sweden, UK for conservation and Norway	No	Finland, Netherlands, Sweden and Norway	Finland, Netherlands, Sweden and Norway
Current use in biological monitoring or classificat-ion in Estonia	Yes	No, scientific investigations only	No	Yes	Yes, but mainly the commercial fish stocks are monitored
Current use in biological monitoring or classificat-ion in Russian Federation	No, scientific investigations only		No	No	Yes, but mainly the commercial fish stocks are monitored

Результаты определений, выполненные российской стороной в рамках совместной Программы ведения мониторинга водных объектов на основе

Российско-Эстонского Соглашения в области охраны трансграничных вод в марте 2004 года

Водный объект - оз. Псковско-Чудское

Определяемые показатели

Верти-каль №	Горизонт	Дата отбора пробы	Темпе-ратура воздуха, °С	Ветер (направ ле-ние/ скорост ь, м/с)	Визуальные признаки загрязнения в месте отбора пробы	Глубина, м	Прозрач -ность, м	Темпе-ратура воды,°С	Содер-жание раство-ренного O_2, мг/л	% насы-щения O_2	Содер-жание CO_2, мг/л	pH	Запах, баллов	БПК 5, мг/л	Сод-ие карбонат-ных ионов мг/л
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	поверхн.	9 märts	-2,3	ЗАП.-1		0,5	3,00	0,0	14,10	99,0	8,36	8,40		1,5	
2	дно							2,3	1,70	12,0		7,91			
	поверхн.	9 märts	-1,5	ЗАП-1		0,5	2,80	0,0	13,70	95,0	9,68	8,30		1,9	
4	дно							2,2	0,30	2,0		8,01			
5	поверхн.	9 märts						0,0	13,70	95,0		7,62			
	дно							1,3	6,20	45,0		7,54			
7	поверхн.	9 märts	1,0	СЗ-1		0,5	2,50	0,0	13,90	98,0	8,80	7,70		0,6	
10	поверхн.														
	дно														
	поверхн.	9 märts	2,4	ЗАП-1		0,5	2,00	0,0	14,10	99,0	11,80	7,70		1,2	
91	дно					9,5		2,3	1,00	7,0		7,50		1,6	
11	поверхн.	9 märts	2,4	ЗАП.-1		0,5	2,00	0,0	12,80	89,0	7,92	7,70		1,4	
	дно							1,9							

12	поверхн.	**9 märts**						0,0	14,40	100,0		7,90			
17	поверхн.	**10 märts**	0,4	**СЗ-1**		0,5	1,00	0,0	13,70	94,0	15,40	7,98		1,6	
16	поверхн.	**10 märts**	-7,0	**СЗ-2**		0,5	1,30	0,0	14,00	97,0	10,12	7,80		1,8	
	дно					14,5		2,2	6,10	44,0	10,12	7,60		2,4	
27	поверхн.	**10 märts**	0,4	**ЗАП-1**		0,5	1,30	0,0	13,80	96,0	13,20	7,80		1,0	
	дно					6,1		1,8	1,80	13,0	13,20	7,50		0,8	
51	поверхн.	**10 märts**	0,4	**СЗ-1**		0,5	1,20	0,0	13,90	97,0	11,00	8,01		1,2	
	дно					4,9		2,0	1,60	10,0	14,50	7,65		1,7	
52	поверхн.	**10 märts**	-5,1	**СЗ-2**		0,5	1,00	0,0	7,10	76,0	16,20	7,72		1,5	
	дно					4,9		1,8	3,00	12,0	14,30	7,30		1,9	
22	поверхн.	**10 märts**	-6,8	**СЗ-5**		0,5	1,20	0,0	7,20	78,0	15,40	7,20		1,1	
	дно					3,9		1,8	3,40	24,0	15,40	7,20		1,6	

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Результаты определений, выполненные российской стороной в рамках совместной Программы ведения мониторинга водных объектов на основе Российско-Эстонского Соглашения в области охраны трансграничных вод в марте 2004 года

Водный объект - оз. Псковско-Чудское

APPENDIX 4

Верти-каль №	Горизонт	Определяемые показатели													
		Азот аммонийный	Азот нитритный	Азот нитратный	Сумма азота минерального	Азот общий	Фосфор минеральный	Фосфор общий	Фосфор валовый	Железо (общее)	Кремнекислота	Нефте-продукты	Летучие фенолы	Взвешенные вещества	ХПК
		мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л
1	2	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2	поверхн.	0.07 0.028	< 0,010 0.004	0.160 0.170	0,230	1.20 0.59	< 0,010 0.004	0,070	0,012	0,05			0,0021		
	дно	0,023	0,004	0,480		1,00	0,008	0,024				0,021		2,70	38,64
4	поверхн.	0.09 0.023	< 0,010 0.003	0.140 0.140	0,230	1.10 0.61	< 0,010 0.011	0,030	0,064	0,12		0,039	0,0009	14,30	42,32
	дно	0,032	0.003	0,120		0,57	0,010	0,022							
5	поверхн.	0,030	0,003	0,090			0,004	0,015							
	дно	0,026	0,003				0,007	0,019							
7	поверхн.	0.03 0,020	< 0,010	1,020	1,050	1.10 0.49	< 0,010 0.005	0,023	< 0,010	< 0,05		0,046	0,0047	4,10	46,00
10	поверхн.														
	дно														
91	поверхн.	0.09 0.045	< 0,010 0.003	0.300 0.330	0,390	0.70 0.73	< 0,010 0.009	0,022	0,012	0,11		0,052	0,0004	5,20	44,16
	дно	0.07 0.036	< 0,010 0.006	0.340 0.410	0,410	0.49 0.84	< 0,010 0.012	0,031	0,024	0,08		0,048	0,0023	5,60	46,00
11	поверхн.	0.08 0,026	< 0,010 0.006	0,210 0.200	0,290	0.54 0.62	< 0,010 0.012	0,020	0,012	< 0,05		0,029	0,0054	2,00	42,32
	дно	0,046	0,007	0.710		1,00		0,024							

12	поверхн.														
17	поверхн.	<0,02	< 0,010	0,650	0,650	0.80 1.29	0,018	0,039	0,024	0,31		0,041	0,0035	1,70	38,64
16	поверхн.	0.06 0.020	< 0,010	0.640 0.700	0,700	1.04 1.36	0.010 0.022	0,040	0,024	0,33		0,046	0,0016	4,40	40,48
Эстония	дно	0.02 0.020	< 0,010	0.680 0.680	0,700	0.72 1.31	0.022 0.030	0,054	0,036	0,51		0,034	0,0047	0,60	44,16
27	поверхн.	<0,02 0.020	< 0,010	0.650 0.720	0,650	0.85 1.30	0.018 0.023	0,039	0,024	0,31		0,064	0,0026	0,70	44,16
	дно	<0,02 0.023	< 0,010	0.700 0.810	0,700	0.80 1.13	0.012 0.025	0,039	0,036	0,45		0,054	0,0032	4,10	41,40
51	поверхн.	<0,02 0.080	< 0,010	0.710 0.810	0,710	0.90 1.37	0.012 0.022	0,039	0,024	1,29		0,075	0,0015	2,20	36,80
	дно	<0,02 0.020	< 0,010	0.700 0.740	0,700	0.80 1.34	0.018 0.022	0,036	0,036	0,64		0,034	0,0021	11,70	38,64
52	поверхн.	0.05 0.037	< 0,010	0.840 0.860	0,890	0.90 1.10	0.018 0.022	0,058	0,036	0,45		0,041	0,0026	1,30	45,08
	дно	0.100 0.180	< 0,010	0.800 0.760	0,900	1.00 1.23	0.022 0.044	0,056	0,056	0,52		0,060	0,0035	2,10	41,40
22	поверхн.	0.130 0.200	< 0,010	0.760 0.770	0,890	0.90 1.28	0.032 0.042	0,056	0,044	0,60		0,049	0,0032	2,30	39,56
	дно	0.130 0.190	< 0,010	0.800 0.780	0,930	1.00 1.12	0.032 0.042	0,055	0,104	0,60		0,051	0,0036	27,80	44,16

NB! Russian data - black, Estonian data red ***Take notice to big number of the results, which are lower than detection limit!***

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