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INTERNATIONAL ADVANCED WATER TECHNOLOGIES CENTRE, IAWTC/LADEC AND LUT 2013

Questionnaire Responses from Russian Drinking Water and Wastewater Treatment Plants

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ABSTRACT

In this report, information is published concerning Russian water and wastewater treatment plants. The information is based on a questionnaire sent to 70 water and wastewater treatment plants in 2012-2013. The questionnaire was prepared by the International Advanced Water Technologies Centre (IAWTC) and Lahti Development Company (LADEC). The questions dealt with an assessment of the present state, the need for changes, renovation, investments, and how to improve the efficiency of the operation by training and investments.

A significant need to renew the old pipelines, constructions, and processes was clearly evident. The aggregated answers can be utilized in Russia as internal benchmarking in order to arrange training and plant visits, which were requested in many of the answers. Sharing this open report with the respondents can aid networking and awareness of HELCOM requirements which relate to waste water treatment plants discharging their waste water directly or indirectly into the Baltic Sea.

The aim of this report is to provide information for Finnish small and medium size companies (SMEs) as regards possible water related exportation to different parts of Russia.

Keywords: Russian waterworks, questionnaire study, assessment of present state, investments

CONTENTS

1. INTRODUCTION

Russian water and to wastewater treatment plants were sent a questionnaire inquiring about their present state, future needs for renovations and new constructions. Furthermore, the questions dealt with new investments and training to improve the efficiency of the plants.

2. METHODS

The questionnaire was prepared by the International Advanced Water Technologies Centre (IAWTC) and the Lahti Development Company (LADEC). The questionnaire was sent in December 2012 to 70 Vodokanal plants (both water and wastewater treatment plants) mainly by email and some by fax. By the end of 2013, a total of 19 responses from water plants and 16 responses from wastewater treatment plants were received. Geographically, the respondents were scattered over different parts of the Russian Federation. The westernmost response was received from Kaliningrad, the northernmost from Apatity, located on the Kola Peninsula, the southernmost from Novosibirsk and the easternmost from Yakutsk, which are all shown in Figure 1. The same questions were sent to all, but there seems to have been a possibility to amend the questionnaire. The inquiry of IAWTC/LADEC in Russian is presented in Appendix 1.

Figure 1. Map of the Russian Federation. Source: https://google.fi/ 29 January 2014

3. WATER PLANTS

3.1 General information about water plants

The oldest Russian water treatment plant was founded in 1927 in Rostov and the newest one, based on responses, in 1987 in Apatity. There was already a water supply source in 1864 in Orenburg.

The operational expenses of the water plants were based on current rates. The content of the rates were not specified in the responses. The costs of water purification in 2012 varied between 2.33 rubles/m^3 and 29.43 rubles/m^3 in the responses. The average price of water purification is 10.64 rubles/m^3. The inhabitants of the cities pay 11.33 – 36.34 rubles/m^3 for drinking water. The average price of the water is 16.88 rubles/m^3. This price may also partly contain the price of wastewater treatment. In three cases, inhabitants pay less for water than its reported production costs. In one case, the price is equal to the production costs, and the rest of the cities charge more.

In 14 cases, the surface water of a river or a lake is used as raw water for the purification process. Five water plants use surface or ground water as their raw water source. Only the water treatment plant of Pikalevo uses ground water. No other water sources are available except in Omsk, where there are ground water wells. The production of drinking water is 0.7 – 1224.6 million m^3/year. The smallest water treatment plant based on the amount of purified water is located in Umba in the Murmansk oblast, and the largest is Moscow's water treatment plant.

3.2 Maintenance repairs and investments

The advanced age and length of the water supply network are challenging for the quality of drinking water. The annual maintenance and renovation of the pipes and buildings are needed besides investments. The oldest water supply pipelines are 98 years old and situated in Omsk, whereas the newest is in Nizni Novgorod, and only 30 years old. The average age of the water supply pipelines is approximately 50 years. In comparison, 50 years is considered in Finland as the technical age of water supply lines. According to the responses, there are no leakages into the environment. However, in the worst case

approximately 50 % of the produced drinking water leaks into the environment. Usually broken water pipelines are detected by pressure drops.

The reported investments concerned modernization, structural improvements, the recycling of washing waters, and the improvement of water quality in the outgoing water. The hygienic quality of water was planned to be improved by ozonation, ultraviolet (UV) light and sodium hypochlorite. There was also an intention to change the disinfectant from elementary chlorine to sodium hypochlorite.

3.3 Use of water and purification methods

The amount of processed water and the purification methods are listed in Table 1. Purification processes are chosen according to the quality of incoming raw water. The process of drinking water purification has to fulfill the drinking water criteria. The response of Pikalevo mentioned that drinking water has to be safe both epidemiologically and radiologically, must not be dangerous in its chemical consistency and must taste good. In the Russian Federation, the quality requirements are based on the SanPiN "Drinking water" 2.1.4.1074-01 regulations. Besides these regulations, Omsk Vodokanal had listed GN 2.1.5.1315 -03 as an additional requirement. This regulation includes the maximum allowable concentrations for a total of 1356 substances and chemical compounds. According to all responses, the outgoing drinking water from the water plants fulfills the demands.

Table 1. The amount of purified raw water per year and the purification process applied

Water plant	**Purified water million m^3/a**	**Purification method used for raw water**
Nizni Novgorod, New Sormovskaja	109.0	Sand filtration, chemical precipitation and the chlorination of outgoing drinking water.
Nizni Novgorod, Avtozavodskaja v/s	13.5	Sand filtration, chemical precipitation and the chlorination of outgoing drinking water.
Nizni Novgorod, "Malinovaja grjada"	40.0	Sand filtration, chemical precipitation, ozonation, chlorination and the UV radiation of outgoing drinking water.
Nizni Novgorod	35.0	Sand filtration, chemical precipitation, ozonation/oxidation, chlorination and the UV radiation of outgoing drinking water.
Kaliningrad, southern N:o 2	28.97	No information
Kaliningrad, eastern	9.42	No information
Apatity, Kirovsk	7.37	UV radiation of outgoing drinking water.
Apatity, Umba	0.66	Sand filtration and the chlorination of

		outgoing drinking water.
Apatity	8.55	Sand filtration and the chlorination of outgoing drinking water.
Pikalevo	3.56	The groundwater is disinfected by sodium hypochlorite.
Novgorod	39.85	Sand filtration, chemical precipitation and the chlorination of outgoing drinking water.
Vodokanal	No information	Sand filtration, chlorination and the UV radiation of outgoing drinking water.
Slantcy	4.8	Sand filtration, chemical precipitation and the chlorination of outgoing drinking water.
Ivanovo	28.0	Sand filtration, the chlorination of outgoing drinking water and secondary clarification
Omsk	152.2	Sand filtration, the chlorination of outgoing drinking water and secondary clarification
Sosnovi Bor	No information	No information
Orenburg	64.5	Sand filtration, chemical precipitation, chlorination and the UV radiation of outgoing drinking water. Reverse osmosis installation is taking place.
Cherepovets	No information	Sand filtration, chemical precipitation, the UV radiation of outgoing drinking water and other treatment.
Kostroma	37.3	Sand filtration, the chlorination of outgoing drinking water and other filtration.
Rostov	192.4	Sand filtration, chemical precipitation, chlorination and the UV radiation of outgoing drinking water.
Yakutsk	27.0	Sand filtration and the chlorination of outgoing drinking water.
Moscow	1224.6	Sand filtration, chemical precipitation, ozonation/oxidation, active carbon filtration, chlorination, and the UV radiation and membrane filtration of outgoing drinking water.

Solids such as humus are removed from the incoming water by sand filtration. Aluminum or iron based compounds are generally used as flocculation aids to make the process more effective. In some responses, it was mentioned that metals are removed from raw water, but these water treatment plants did not report about chemical precipitation or other systems used for metal removal.

The most common method to disinfect the outgoing drinking water was chlorination or by sodium hypochlorite. Some water plants reported changing the use of chlorine to sodium hypochlorite. In some water plants, the hygienic quality of water is ensured by ozonation

and UV radiation. Ozonation improves the taste and the odor of the drinking water. Only two water plants used UV radiation for disinfection.

Methods which improve the taste of water, such as nanofiltration, activated carbon filtration or reverse osmosis, were not commonly in use. Orenburg currently installing reverse osmosis equipment. Activated carbon and membrane filtration was used in the water purification process only in Moscow.

Based on responses, organic matter/humics, metals, salts, and bacteria/viruses are measured according to the parameters of SanPin "drinking water" 2.2.4.1074-01 from the outgoing tap or drinking water.

3.4 Personnel and future needs for training

The size of each water plant was also illustrated by the number of staff members. Also the professional background of the personnel is listed in Table 2.

Table 2. The water plants and the professional background of their personnel

Water plant	Total number of employees	Vocational training	Secondary level	Higher education	Other training
Nizni Novgorod, New Sormovskaja	110				
Nizni Novgorod, Avtozavodskaja v/s	53				
Nizni Novgorod, "Malinovaja grjada"	77			11	
Nizni Novgorod	84	23	8	12	
Kaliningrad, southern N:o 2	78	4	19	19	
Kaliningrad, eastern	No information				
Apatity, Kirovsk		3	1	1	5
Apatity, Umba		3	2		4
Apatity*	365/36	10	2	1	4
Pikalevo	8	4		1	3
Novgorod	783	243	164	211	165
Vodokanal	65	33	18	14	
Slantscy	160	104	40	16	
Ivanovo	40				

Omsk	1966	467	754	745	
Sosnovi Bor**	9	4	3	2	
Orenburg	1091	288	208	309	286
Cherepovets	620	170	104	190	150
Kostroma	No information				
Rostov	2644	421	1282	858	256
Yakutsk	48	5	34	9	
Moscow	13898	5564	3537	4479	318

* In the Apatity water plant, the total number of employees is 365 people, 36 of whom are working in water purification. ** In Sosnovi Bor, nine people are working in water purification.

Work orientation and other training is given in the water plant. The personnel from six water plants has been in training in the Vodokanal of St. Petersburg. People from five water plants have received training in Moscow. Also the large cities nearby have arranged training. Seminars, training and visits to other water plants were supported by all respondents. Also conferences, possibilities to share experiences and other activity increasing the professional level were wished.

The responses indicated that the most popular themes of additional training were purification technology, water plant maintenance, automation, instrumentation and energy efficiency, whereas management and financial administration were the less interesting. The proposed themes for training are presented in Table 3.

Table 3. Training needs

The theme of the training	**Answers**
Purification technology	16
The maintenance and repair of equipment	14
The maintenance and repair of pipeline	13
Automation	14
Measuring technology (Instrumentation)	15
Energy efficiency	15
Legislation	9
The financial administration of the plant	7
Technical management	10
Management of the plant	6
Human resource management	10
How to organize water	9

management	
Other theme, what?	How to put modern purification technology into practice. The development of the design documentation system.

4. WASTEWATER TREATMENT PLANTS

4.1 General information about wastewater treatment plants

Wastewater treatment plants discharge their cleaned wastewater to recipient waterbodies, that is, rivers, lakes or directly into the sea. The wastewater treatment plants in Slantcy near the eastern border of Estonia and in Sosnovy Bor discharge wastewaters into the Gulf of Finland. Kaliningrad discharges its wastewaters directly into the Baltic Sea. HELCOM recommendations 28E/5 adopted on 15 November 2007 concern these wastewater treatment plants with a load of 10 001–100 000 person equivalents. There are recommendations for biological oxygen demand, BOD_5. The reduction of BOD_5 in the purified waste water should be below 80% or 15 mg/liter as a typical concentration in the near future. There should be at least an 80% reduction of total phosphor or at most a concentration of 0.5 mg/l of total phosphor in the effluent of the treatment plant when discharging purified water directly or indirectly into marine areas. The minimum reduction of total nitrogen should be 70-80 % or the maximum concentration of total nitrogen in the effluent of the treatment plant should be lower than 15 mg/l or 10 mg/l. The limit depends on the person equivalents when wastewater treatment plants are discharging directly or indirectly into marine areas sensitive to nitrogen. The Contracting States of HELCOM committed to fulfilling the demands for discharges from agglomerations of more than 200 000 person equivalents by December 2010.

4.2 Costs of the wastewater purification and wastewater volumes per plants

The price of the wastewater purification varies between 1.54 rubles/m^3 (2011) and 21.98 rubles/m^3. The average purification price is 10.42 rubles/m^3. The price paid by the inhabitants for wastewater purification varies between 5.75 and 19.44 rubles/m^3. In six cases, the price was even lower than the reported production costs. In some cities the production costs were the same as the fees collected from the inhabitants. In all other reported cases, the inhabitants paid more than the wastewater treatment costs. Information about the treated wastewater and the amount of wastewater used per inhabitant is displayed in Table 4. All waste water treatment plants have not answered the questions regarding whether they also treat industrial effluents and storm waters.

Table 4. The amount of incoming wastewater to treatment plants, million m^3 /year, and the used water per inhabitant, m^3/year.

Wastewater treatment plant	**Influent to wastewater treatment plant, million m^3/a**	**Effluents from industry, million m^3/a**	**Storm water, million m^3/a**	**Waste-water*** /inhabitant, m^3/a**
Nizhni Novgorod	268.8	48.8	96.0	118.2
Ivanovo	56.0		3.0	129.3
Omsk	140.0	21.4	0.3	122.7
Sosnovi Bor	-	-	-	-
Orenburg	67.5	10.0	Yes, -	100.8
Cherepovets	46.3	9.0	1.0	117.1
Slantcy	0.03	No	No	39.3
Novosibirsk	192.0	Yes	Not yet	96.0
Petrozavodsk	33.0	Yes	Yes	122.2
Tula	77.0	8.8	No	168.2
Pikalevo	2.9	No	No	132.2
Apatity/Kirovsk	7.9	Yes	Yes	-
Apatity / Umba	0.9	Yes	Yes	-
Apatity	1.0	Yes	Yes	-
Kaliningrad	49.4	-	10.4	99.9
Kostroma	37.0	30-50%	10-15%	74.7
Rostov	94.7	Yes	No information	86.1
Yakutsk	25.2	Yes	No information	172.2

*** The amount of wastewater per inhabitant is calculated by the reduction of effluents and storm water from the influent to the wastewater treatment plant and by dividing the sum by the given person equivalent.

The treatment of industrial wastewaters and storm waters may be challenging since they do not contain organic matter needed for biological treatment. Also the great amount of storm waters may weaken wastewater purification. There are differences in how people use water in different citie. The calculated minimum volume of water was 106 liters/day and the maximum up to 470 liters/day per inhabitant. In Finland, the average use of drinking water is roughly 120 - 155 liters/day per inhabitant, depending on the type of accommodation.

4.3 Maintenance repairs and investments

According to the responses, a majority of the wastewater treatment plants was built in the early1970s. The oldest plant was built in Kaliningrad in 1924 and the newest one was the third stage of Chrepovet's wastewater treatment plant. The oldest sewage pipes dated back 84 years. The most recently built pipes were roughly 30 years old. The average age the sewage pipes was 50 years and they were at the end of their technical age. The most important needs for repairs and investments are presented in Table 5.

Table 5. Needs for repairs and investments

Wastewater treatment plant	**Needs for repairs**	**Investments**
Nizhni Novgorod	The substitutions of five screens, the repair of two biological basins and the maintenance of a chlorinator.	To update the wastewater treatment plant.
Ivanovo	Maintenance and repairs are performed continuously.	Rebuilding of the first phase of the wastewater treatment plant.
Omsk	Preventive maintenance is done constantly. More extensive repair work is done during planned shutdowns.	Modernization of the wastewater treatment plants.
Sosnovi Bor	-	-
Orenburg	In addition to yearly repairs, basic maintenance is carried out on the primary and secondary clarifiers.	Building of a water removal system for sludge.
Cherepovets	Repairs are carried out according to the schedule.	The first and second phases of the water treatment plant need repairs.
Slantsi	New system building	No
Novosibirsk	Basic maintenance is performed constantly according to a scheme. Rebuilding and modernization are needed.	Biological method for the removal of nitrate and phosphorus. UV-disinfection.
Petrozavodsk	Basic in-line repairs are performed.	Rebuilding and modernization of the wastewater treatment plant.

Tula	Constant repairs of the buildings and pipelines.	Renewal of equipment and aeration basins.
Pikalevo	Development and building work done in the pump house KOS-1. Biofilters.	
Apatity, Kirovsk	Implementation of the Best Available Technology (BAT) to improve efficiency.	Investments are focused on the building of UV-disinfection.
Apatity, Umba	-"-	-"-
Apatity	-"-	-"-
Kaliningrad	Small structural repairs.	Plans for a new wastewater treatment system at the end of 2013.****
Kostroma	No information about repairs.	
Rostov	No information about repairs.	
Yakutsk	Changes of sieves and repairs both sieves and pumps are done.	

**** The building of the wastewater treatment plant in Kaliningrad has started in 1976. According to an article of the Finnish newspaper "Helsingin Sanomat", October 2nd, 2013, a new wastewater treatment plant will be ready for operation no earlier than at the end of 2014.

4.4 Wastewater treatment processes

The processes now in use are presented in Table 6. The European Union recommends also Best Available Techniques (BAT) for wastewater treatment plants. The purification requirements of the effluent are presented in BAT. There is no knowledge about similar legislative procedures in the Russian Federation. Legal obligations were described only in part of the answers.

Table 6. Processes of the wastewater treatment plants and substances they remove from the influent.

Wastewater treatment plant	**Purification process**	**Removed substances**
Nizhni Novgorod	Mechanical, chemical and biological treatment, sludge treatment and disinfection	Phosphorus, total nitrogen, nitrate nitrogen, organic substances, suspended

	of the effluent.	solids. Besides metals, petroleum products and detergents are removed.
Ivanovo	Mechanical and chemical treatment.	Phosphorus, total nitrogen, organic substances and suspended solids.
Omsk	Mechanical and biological treatment. Fast single-layer filter for the feeding of the sand.	Total nitrogen, organic substances, suspended solids, petroleum products, volatile phenol compounds, ammonia nitrogen, sulphate, sulphite, detergents, formaldehyde, aluminum, total iron, copper, chromium(III), zink, acetone, a-methylstyrene, isopropylbentzene, acetonitrile, bentzene
Sosnovi Bor	-	Organic and suspended solids.
Orenburg	Mechanical and biological treatment.	Phosphorus, total nitrogen, nitrate nitrogen, organic and suspended solids.
Cherepovets	Mechanical, biological and other treatment.	Phosphorus, total nitrogen, nitrate nitrogen, organic and suspended solids.
Slantcy	Biological treatment.	Phosphorus, total nitrogen, nitrate nitrogen, organic and suspended solids calculated as BOD.
Novosibirsk	Mechanical and biological treatment.	Partly phosphor, partly total nitrogen, organic and suspended solids.
Petrozavodsk	Mechanical and biological treatment.	Phosphorus, total nitrogen, nitrate nitrogen, organic and suspended solids, ammonia nitrogen, nitrite nitrogen, chloride and sulphate.
Tula	Mechanical and biological treatment.	Partly phosphorus, total nitrogen, nitrate nitrogen, organic and suspended solids.
Pikalevo	Mechanical and biological treatment.	Phosphorus, total nitrogen, nitrate nitrogen, organic and suspended solids.
Apatity, Kirovsk	Mechanical and biological treatment.	Suspended solids, petroleum products, BOD,

		ammonium ions, nitrate ions, surfactants, phosphorus as phosphate, dry residue, chloride, iron and sulphate.
Apatity, Umba	-”-	-”-
Apatity	-”-	-”-
Kaliningrad	Mechanical treatment.	-
Kostroma	Mechanical and biological treatment.	Total nitrogen, organic and suspended solids, grease, oil products and surfactants.
Rostov	Mechanical and biological treatment	Phosphorus, total nitrogen, organic and suspended solids, surfactants, oil products, metals and fluorides.
Yakutsk	Mechanical and biological treatment	Total nitrogen, organic and suspended solids.

4.5 Monitoring of the effluent and the quality of the released water

The biological processes of wastewater treatment plants are designed to remove organic, biodegradable or by precipitation easily removable load suspended solids, BOD (Biological Oxygen Demand), nitrogen and phosphorus contents in the effluent. The quality of the surface or the purified wastewater is estimated based on the total phosphorus, total nitrogen and suspended solids. In addition, many other parameters can be used, e.g. COD (Chemical Oxygen Demand). The monitoring parameters of wastewater are presented in Table 7. The results of the treatment processes are collected in Table 8. The questionnaire inquired about the quantities of total phosphorus, total nitrogen, organic matter as BOD and suspended solids. The unit was mg/l. The respondent could choos from three to five alternative answers or state that he or she had no information. The questions can be found in Appendices in Russian.

Table 7. The parameters used in the monitoring of the effluent.

Wastewater treatment plant	**Monitoring parameters**
Nizhni Novgorod	BOD, COD, total nitrogen calculated as ammonia nitrogen, nitrate nitrogen, total phosphorus calculated as phosphor phosphate, suspended solids and heavy metals.
Ivanovo	BOD, COD, nitrate nitrogen, the phosphorus content is

	measured as phosphate, suspended solids, heavy metals, ammonium and nitrite ions, petroleum products, detergents, chloride, sulphite and sulphate.
Omsk	BOD, COD, total nitrogen, nitrate nitrogen, total phosphorus, suspended solids, heavy metals, petroleum products, volatile phenols, ammonium nitrogen, nitrite ions, phosphate ions, chloride, sulphate, sulphite, detergents, formaldehyde, dry residue, calcinated residue, hydrocarbons (acetone, a-methylstyrene, isopropylbentzene, acetonitrile, styrene, bentzene, o-xylene, toluene)
Sosnovi Bor	BOD, COD, total nitrogen, nitrate nitrogen, total phosphorus, suspended solids and heavy metals.
Orenburg	BOD, COD, total nitrogen, nitrate nitrogen, total phosphorus, suspended solids, heavy metals, petroleum products, phenol, detergents (anionic surfactants) and greases.
Cherepovets	BOD, COD, total nitrogen, nitrate nitrogen, total phosphorus, suspended solids and heavy metals.
Slantcy	BOD, COD, total nitrogen, nitrate nitrogen, total phosphorus and suspended solids.
Novosibirsk	BOD, COD, total nitrogen, nitrate nitrogen, nitrite and ammonia nitrogen, phosphorus, phosphates, suspended solids, heavy metals and from tank: petroleum products, phenol, the anionic compounds of detergents, pH, hydrogen sulphide, chloride, sulphides, fluoride ions and ash.
Petrozavodsk	Nitrate nitrogen, phosphate, sulphate, chloride, anionic surfactants, petroleum products, greases and phenols.
Tula	BOD, nitrate nitrogen, total phosphorus, suspended solids and heavy metals.
Pikalevo	BOD, COD, nitrate nitrogen, nitrate nitrogen and suspended solids.
Apatity (Kirovsk, Umba and Apatity)	Volume, temperature, visibility depth, pH, BOD, COD and suspended solids.
Kaliningrad	BOD, COD, total nitrogen, nitrate nitrogen, total phosphorus, suspended solids and heavy metals.
Kostroma	Total nitrogen, organic and solid matter, grease, oil products and surfactants.
Rostov	Phosphorus, total nitrogen, organic and solid matter, oil products, surfactants, metals and fluorides.
Yakutsk	Total nitrogen, nitrate nitrogen, organic and solid matter.

Table 8.The results of the purified wastewater and the quantity of total nitrogen, total phosphorus, BOD and suspended solids.

Wastewater treatment plant	Total phosphorus, mg/l	Total nitrogen, mg/l	BOD, mg/l	Suspended solids, mg/l
Nizhni Novgorod	1 – 2	10 – 15	< 15	< 35
Ivanovo	1 – 2	No information	< 15	< 35
Omsk	>3	15 – 30	< 15	< 35
Sosnovi Bor	No information	No information	< 15	< 35
Orenburg	2 – 3	< 10	< 15	< 35
Cherepovets	No information	No information	No information	No information
Slantcy	2 – 3	< 10	25 - 30	35 - 50
Novosibirsk	1 – 3	10 – 15	< 15	< 35
Petrozavodsk	2 – 3	15 – 30	< 15	< 35
Tula	No information	No information	No information	No information
Pikalevo	< 0,5	< 10	< 15	< 35
Apatity /Kirovsk	0.5 -1	> 30*	< 5	< 15
Apatity, Apatity	1 -2	> 30*	< 5	< 10
Apatity, Umba	1 – 2	> 30*	15 – 25	< 15
Kaliningrad	>3	> 30	> 30	> 50
Kostroma	2 – 3	< 10	< 15	< 35
Rostov	1 – 2	10 – 15	15 - 25	< 35
Yakutsk	2 - 3	10 – 15	< 15	< 35

Note: the nitrogen results are given as nitrate nitrogen.

According to the results of the purified wastewater, none of the wastewater treatment plants reach the HELCOM recommendation limit 0.5 mg/l total phosphorus in the effluent. Four wastewater treatment plants operate under the other nutrient limit, total nitrogen 10.0 mg/l. The situation is better with BOD. The results of 12 plants are under the limit 15 mg/l BOD in the effluent. Particularly in the wastewater treatment plants that release their effluents into the Baltic Sea or the Gulf of Finland there is need to intensify the purification process of phosphorus and nitrogen nutrients.

4.6 Sludge treatment

There are only digesters in Nizni Novgorod, Orenburg, Kostroma and Novosibirsk, where cationic flocculants are used before the mechanical treatment of the sludge. There are no digesters in Sosnovi Bor, but the sludge is allowed to thicken aerobically. The reported wastewater treatment plants do not utilize the dried sludge or the gas of the digesters as

energy at this moment. Only Yakutsk utilizes the energy of the sludge. Pikalevo and Rostov compost the sewage sludge. Both in Nizni Novgorod and Novosibirsk, the dried sludge is used for soil improvement. In Pikalevo, part of sludge is dried and utilized as fertilizer in the gardens and parks of the city. Only the bottom deposit of the sludge is not utilized due its dangerous properties.

There may be local or national regulations concerning the incineration of sludge. Moreover, regulations may exists on digested sludge or composted sludge and how to use it. According to the responses, heavy metals such as Fe, Cu, Ni, Co, Cd, Pb, Zn and Cr are controlled by analyzing the content in the sludge one to five times a year. Both nitrogen and phosphorus nutrients are controlled in a similar way. The responses diverge clearly. There are wastewater treatment plants which do not analyze any possible harmful substances or parasites in their sludge.

4.7 Personnel and future needs for trainings

Many wastewater treatment plants provide in-house training. The employees of six plants have received training either in the St. Petersburg' Vodokanal or in Moscow. Also the wastewater treatment plants in large cities have provided training to other plants. Only personnel from Kaliningrad has taken part in training abroad in Sweden. All wastewater treatment plants reported they have budgeted appropriations for personnel training. The number of people working in wastewater plants and their professional background are listed in Table 9. According to many responses, many wastewater plants people have employees with no training.

Table 9. Number of staff members in wastewater treatment plants and their educational background

Wastewater treatment plant	Total number of employees	Vocational training	Secondary level	Higher level	Other training
Nizhni Novgorod	149			24	
Ivanovo	70				
Omsk	1966	467	754	745	
Sosnovi Bor	64	14	13	7	40
Orenburg	1091		309	251	35
Cherepovets	No informa-tion	No informa-tion	No informa-tion	No information	No information
Slantscy	160	104	40	16	
Novosibirsk	3400	288	946	918	1488

Petrozavodsk	654	No information	No information	No information	No information
Tula	No information	No information	No information	No information	No information
Pikalevo	40	14	8	6	14
Apatity, Kirovsk, Apatity, Umba	355	129*	71*	68*	35*
Kaliningrad	58	8	1	22	
Kostroma	991	138	611	218	24
Rostov	2664	421	1282	685	256
Yakutsk	57	20	12	12	13

* The figures concern only workers.

All proposed training, seminars, practical training and fact-finding tours to other wastewater plants were supported. Only few wastewater plants did not declare the themes for the training. The proposed themes for training and responses are shown in Table 10.

Table 10. Training themes

Theme of the training	**Answers**
Nutrient removal	6
Sludge treatment technologies	10
Utilization of sludge	10
Maintenance and repair of equipment	8
Automation	9
Measuring technology (Instrumentation)	10
New wastewater treatment technologies	10
Energy efficiency	10
Legislation	9
The financial administration of the plant	6
Technical management	7
Management of the plant	6
Human resource management	6
How to organize water management	6

Other theme, specify?	Development of the design documentation system.

The scores of the training themes were quite similar. Only nutrient removal and management were assessed to be less relevant. Nine wastewater plants were ready to sign an agreement with the St. Petersburg' Vodokanal. Two wastewater plants were only interested in single contracts on concrete services or on seminars depending on their price.

5. SUMMARY

Sending the questionnaire near the end of the year just before the holiday season may reflect on the number of responses. Some of the respondents had answered in great detail. They familiarized themselves with the questionnaire and spent time on the answers. The most thorough answer concerning water plants came from Omsk and the corresponding wastewater treatment plant answer came from Apatity, the Kola Peninsula. Some responses lacked important contact information and some pages were missing. In the near future, more detailed questions could be prepared. The questionnaire could be modified to obtain more information about the current state of the plants. There were no questions about precipitation with chemicals, pH regulators and polymers, which are commonly used in the settling of solids.

There is a significant need to renew the old pipelines and constructions. Also the purification processes should be renewed. Furthermore, new plants need automation and instrumentation to operate properly. More preventive maintenance and training are needed in the future. Collaborative project management and training with Russians could be export products of small and medium-sized enterprises in the future.

References

1. HELCOM recommendations https:// helcom.fi/Recommendations/Rec 28E-5.pdf

2. Saavalainen, Heli, Viemärivesi Itämereen (Sewage water into Baltic Sea), Helsingin Sanomat, 2 October 2013.

APPENDICES

I Questionnaire of IAWTC / LADEC in Finnish

II Questionnaire of IAWTC / LADEC in Russian

APPENDIX I

Jätevedenpuhdistamot

1) Laitoksen perustiedot

Laitoksen nimi ja osoite

Yhteyshenkilön tiedot (nimi, asema, sähköpostiosoite, puhelinnumero)

Vastaajan tiedot (nimi, asema, sähköpostiosoite, puhelinnumero)

Minä vuonna laitos on rakennettu?

Kuinka vanhoja jätevesiputket ovat?

Miten laitoksen rakentaminen on rahoitettu?

Miten käyttökulut katetaan?

Paljon jäteveden puhdistaminen maksaa (ruplaa/m3)?

Paljon asukas joutuu maksamaan jäteveden käsittelystä (ruplaa/m3)?

Laitoksen asukasvastineluku

Laitokselle tuleva jätevesimäärä (vuodessa)?

Tuleeko laitokselle teollisuusjätevesiä? kyllä ei

Kuinka paljon (vuodessa)?

Tuleeko laitokselle hulevesiä? kyllä ei

Kuinka paljon (vuodessa)?

Onko laitoksella tehty saneerauksia? kyllä, milloin? ei

Onko tarpeita saneeraukselle? kyllä, millaisia? ei

Onko laitoksella investointisuunnitelmia? kyllä ei

Onko laitokselle tulossa investointeja kahden vuoden sisällä? kyllä ei

jos on, mihin investointi kohdistuu?

jos ei, olisiko kuitenkin tarpeita investointeihin? kyllä ei

Jos on, millaisiin?

Miten investoinnit rahoitetaan?

2) Käsittelyprosessi

Onko laitoksella käytössä

- mekaaninen käsittely kyllä ei
- kemiallinen käsittely kyllä ei
- biologinen käsittely kyllä ei
- muu, mikä?

Poistetaanko jätevedestä

- fosforia kyllä ei
- kokonaistyppeä kyllä ei
- nitraattityppeä kyllä ei
- orgaanista ainetta kyllä ei
- kiintoainetta kyllä ei
- muuta, mitä?

Velvoittaako lainsäädäntö jotenkin laitoksen toimintaa? kyllä ei

Mikä lainsäädäntö?

Onko laitoksella ympäristölupa? kyllä ei

Mitä lupa sisältää?

Mitä aineita lähtevästä jätevedestä tutkitaan

- ei mitään
- BOD
- COD
- kokonaistyppi
- nitraattityppi
- kokonaisfosfori
- kiintoaine
- raskasmetallit
- muita, mitä?

Onko lähtevässä jätevedessä kokonaisfosforia:

ei tietoa alle 0,5 mg/l 0,5-1 mg/l 1–2 mg/l 2-3 mg/l yli 3 mg/l

Onko lähtevässä jätevedessä kokonaistyppeä:

ei tietoa alle 10 mg/l 10-15 mg/l 15-30 mg/l yli 30 mg/l

Onko lähtevässä jätevedessä orgaanista ainetta (BOD):

ei tietoa alle 15 mg/l 15-25 mg/l 25-30 mg/l yli 30 mg/l

Kiintoainetta:

ei tietoa alle 35 mg/l 35-50 mg/l yli 50 mg/l

3) Lietteen käsittely:

- Mädätetäänkö liete? kyllä ei
- jos kyllä, mitä mädätetylle lietteelle tehdään?
- Kompostoidaanko liete? kyllä ei
- Jos kyllä, mitä kompostoidulle lietteelle tehdään?
- Hyödynnetäänkö lietettä energiana? kyllä, miten? ei
- Sääteleekö lainsäädäntö lietteen loppusijoitusta? kyllä, miten? ei

Mitataanko lietteestä haitta-aineiden pitoisuuksia? kyllä ei

Jos kyllä, minkä aineiden pitoisuuksia?

4) Koulutus

Laitoksen työntekijöiden määrä

Tähän jotain millä selvitetään työntekijöiden koulutustaso

Tietyn tutkintotason suorittaneiden määrä tms.

Onko henkilökuntaa koulutettu heidän työuran aikana? kyllä ei

Jos on, missä?

Omalla laitoksella Pietarissa Muulla Venäjällä, missä? Ulkomailla, missä?

Oliko koulutus maksullista? kyllä ei

Tarvitsisiko laitoksen henkilökunta lisäkoulutusta? kyllä ei

Onko laitoksella määrärahaa henkilökunnan kouluttamiseen? kyllä ei

Missä teemoissa koulutusta tarvittaisiin:

- ravinteiden poisto
- lietteen käsittelytekniikat
- lietteen hyötykäyttö
- laitteiden kunnossapito ja huolto
- automatiikka

- mittaustekniikka
- uudet käsittelytekniikat
- energiatehokkuus
- lainsäädäntö
- laitoksen talouden hoito
- tekninen johtaminen
- laitoksen johtaminen
- Henkilöstöjohtaminen
- Vesihuollon organisointi
- muu, mikä?

VESILAITOKSET

1) Laitoksen perustiedot

Laitoksen nimi ja osoite

Yhteyshenkilön tiedot (nimi, asema, sähköpostiosoite, puhelinnumero)

Vastaajan tiedot (nimi, asema, sähköpostiosoite, puhelinnumero)

Minä vuonna laitos on rakennettu?

Miten laitoksen rakentaminen on rahoitettu?

Miten käyttökulut katetaan?

Paljon veden puhdistaminen maksaa (ruplaa/m^3)?

Paljon asukas joutuu maksamaan puhtaasta vedestä (ruplaa/m^3)?

Mitä käytätte vesilähteenä

- pohjavettä
- tekopohjavettä
- pintavettä
- pohja- ja pintavettä

Onko teillä varavedenottamoita?

Kuinka paljon tuotatte vuodessa puhdasta vettä?

Kuinka vanhoja vesijohtoverkostot ovat?

Kuinka paljon vesijohtoverkostosta valuu vettä ympäristöön (arvio, vuodessa)?

Onko laitoksella tehty saneerauksia? kyllä, milloin? ei

Olisiko tarpeita saneeraukselle? kyllä, millaisia? ei

Onko laitoksella investointisuunnitelmia? kyllä ei

Onko laitokselle tulossa investointeja kahden vuoden sisällä? kyllä ei

jos on, mihin investointi kohdistuu?

jos ei, olisiko kuitenkin tarpeita investointeihin? kyllä ei

Jos on, millaisiin?

Miten investoinnit rahoitetaan?

2) Käsittelyprosessi

Mitä käsittelytekniikoita laitoksella käytetään

- ei mitään
- hiekkasuodatus
- kemiallinen saostus
- otsonointi/hapetus
- aktiivihiilisuodatus
- klooraus
- UV
- muu suodatus
- muu, mitä?

Mitä vedestä poistetaan

- orgaanista ainesta/humusta
- metalleja
- suoloja
- bakteereita/viruksia
- muuta, mitä?
-

Onko lainsäädännössä juomavedelle annettu laatuvaatimuksia? kyllä ei

Jos on, millaisia laatuvaatimuksia?

Täyttyvätkö vaatimukset?

Onko tavoitteena valmistaa juomakelpoista vettä?

Mitä puhdistetusta vedestä mitataan

- orgaanista ainesta/humusta
- metalleja
- suoloja
- bakteereita/viruksia
- muuta, mitä?

3) Koulutus

Laitoksen työntekijöiden määrä

Tähän jotain millä selvitetään työntekijöiden koulutustaso
Tietyn tutkintotason suorittaneiden määrä tms.

Onko henkilökuntaa koulutettu? kyllä ei

Jos on, missä?
Omalla laitoksella Pietarissa muualla Venäjällä, missä Ulkomailla, missä

Oliko koulutus maksullista? kyllä ei

Tarvitsisiko laitoksen henkilökunta lisäkoulutusta? kyllä ei

Onko laitoksella määrärahaa henkilökunnan kouluttamiseen? kyllä ei

Missä teemoissa koulutusta tarvittaisiin:

- Puhdistustekniikat
- laitteiden kunnossapito ja huolto
- putkiston kunnossapito ja huolto
- automatiikka
- mittaustekniikka
- energiatehokkuus
- lainsäädäntö
- laitoksen talouden hoito
- tekninen johtaminen
- laitoksen johtaminen
- Henkilöstöjohtaminen
- Vesihuollon organisointi
- muu, mikä?

APPENDIX II

ОПРОСНЫЙ ЛИСТ ПО КАНАЛИЗАЦИОННЫМ ОЧИСТНЫМ СООРУЖЕНИЯМ

1) Основные данные

Полное название и адрес организации_____

Контактные лица (ФИО, должность, электронный адрес, телефон)

_____

_____

Данные лица, заполняющего опросный лист (ФИО, должность, электронный адрес, телефон)

_____

Год создания сооружения? _____

Возраст канализационного трубопровода? _____

Как покрываются затраты на эксплуатацию?_____

_____

Во сколько обходится очистка сточных вод (рублей/м^3)?_____

Сколько потребитель платит за очистку сточных вод (рублей/м^3)?

_____

Эквивалентное число жителей_____

Какой объем сточных вод поступает на сооружения (в год)? _____

Поступают ли на сооружение промышленные сточные воды? ❑ да ❑ нет

Их объем (в год)? _____

Поступают ли на сооружение ливневые воды? ❑ да ❑ нет

Их объем (в год)?_____

Проводились ли на сооружении ремонтные работы? ❑ да, когда? ❑ нет

_____

Есть ли необходимость в ремонте сооружений? ❑ да ❑ нет

В каком ремонте?_____

Имеется ли у организации инвестиционный план? ❑ да ❑ нет

Планируются ли инвестиции в ближайшие два года? ❑ да ❑ нет

Если да, на что будут направлены первоочередные инвестиционные вложения?

Если нет, есть ли в них все же необходимость? ❑ да ❑ нет

2) Процесс очистки

Применяется ли на сооружении

- механическая очистка ❑да ❑нет
- химическая очистка ❑да ❑нет
- биологическая очистка ❑да ❑нет
- другой тип очистки, какой?

_____

Удаляются ли из сточных вод

- фосфор ❑да ❑нет
- общий азот ❑да ❑нет
- нитратный азот ❑да ❑нет
- органические частицы ❑да ❑нет
- твердые частицы ❑да ❑нет
- другие вещества, какие?

_____

Соответствует ли деятельность предприятия экологическим требованиям национального законодательства по качеству очистки сточных вод? ❑да ❑нет

Имеются ли разрешение на сброс загрязняющих веществ в окружающую среду? ❑да ❑нет

Имеется ли решение о предоставлении водного объекта в пользование?

❑да ❑нет

Что измеряется в сбрасываемых сточных водах:

- ничего
- биохимическое потребление кислорода (BOD/БПК)
- химическое потребление кислорода (COD/ХПК)
- общий азот
- нитратный азот
- общий фосфор
- твердые частицы
- тяжелые металлы
- другое, что?
-

Содержание общего фосфора в сбрасываемых сточных водах:

❑неизвестно	❑менее 0,5 мг/л	❑0,5-1 мг/л	❑1–2 мг/л	❑2-3 мг/л	❑более 3 мг/л

Содержание общего азота в сбрасываемых сточных водах:

❑неизвестно	❑менее 10 мг/л	❑10-15 мг/л	❑15–30 мг/л	❑более 30 мг/л

Содержание органического вещества БПК в сбрасываемых сточных водах:

❑неизвестно	❑менее 15 мг/л	❑15-25 мг/л	❑25–30 мг/л	❑более 30 мг/л

Содержание твердых частиц:

❑неизвестно	❑менее 35 мг/л	❑35-50 мг/л	❑более 50 мг/л

3) Обработка осадка:

- Производится ли сбраживание осадка? ❑да ❑нет
  Если да, каким образом используется сброженный осадок?

  _____

  _____

- Компостируется ли осадок? ❑да ❑нет
  Если да, каким образом используется компостированный осадок?

  _____

  _____

- Используется ли осадок в качестве энергии? ❑ да, каким образом? ❑нет
  _____

  _____

- Измеряется ли в осадке содержание вредных веществ? ❑да ❑нет
  Если да, каких вредных веществ?

  _____

  _____

4) Образование и профессиональная подготовка

Количество сотрудников на предприятии_____

Количество сотрудников, имеющих :

- Начальное профессиональное образование_____
- Среднее профессиональное образование_____

- Высшее профессиональное образование_____
- Другое _____

Проводилось ли обучение для сотрудников за время их карьеры в организации? ❑да ❑нет

Если да, где проводилось обучение?

- Непосредственно на сооружениях ❑
- В ГУП «Водоканал Санкт-Петербурга» ❑
- В других городах России, где? ❑

_____

- За рубежом, где? ❑

_____

Есть ли необходимость в дополнительном обучении сотрудников? ❑да ❑нет

Выделяются ли средства из бюджета организации на обучение сотрудников? ❑да ❑нет

Заинтересовано ли Ваше предприятие в направлении сотрудников на обучение в рамках мероприятий Международного центра передовых водных технологий? ❑да ❑нет

Если да, то в каких?

- В семинарах ❑
- В практическом обучении ❑
- В посещении производственных объектов ❑
- В других мероприятиях (указать тип)
  _____

По каким темам существует необходимость в дополнительном обучении:

- по удалению питательных веществ ❑
- по технологиям обработки осадка ❑
- по утилизации осадка ❑
- по поддержанию оборудования в рабочем состоянии и его обслуживанию ❑
- по автоматике ❑
- по измерительной технике ❑
- по современным технологиям обработки ❑
- по энергоэффективности ❑
- по вопросам законодательства ❑
- по финансово-экономическим вопросам ❑
- по вопросам оперативно-технического управления ❑
- по вопросам управления организацией ❑
- по вопросам управления персоналом ❑
- по вопросам организации ВКХ ❑
- другие темы (указать) ❑

Заинтересовано ли Ваше предприятие заключить рамочное соглашение с ГУП "Водоканал Санкт-Петербурга" на обучение в рамках Международного центра передовых водных технологий?

❑да ❑нет

ОПРОСНЫЙ ЛИСТ ПО ВОДОПРОВОДНЫМ СТАНЦИЯМ

1) Основные данные

Полное название и адрес организации

_____

Контактные лица (ФИО, должность, электронный адрес, телефон)

_____

Данные лица, заполняющего опросный лист (ФИО, должность, электронный адрес, телефон)

_____

Год создания станции?_____

Как покрываются затраты на эксплуатацию? _____

_____

Во сколько обходится очистка воды (рублей/м^3)?_____

Сколько потребитель платит за чистую воду (рублей/м^3)?_____

Что служит источником водоснабжения?

- подземные воды ❑
- грунтовые воды ❑
- поверхностные воды ❑
- подземные и поверхностные воды ❑

Имеются ли запасные источники водоснабжения? _____

Сколько кубометров чистой воды производится в год? _____

Возраст трубопроводов водопроводной сети? _____

Объем утечек из водопроводной сети (приблизительно, в год)?

_____

Проводились ли на станции ремонтные работы? ❑ да, когда? ❑ нет

_____

Есть ли необходимость в ремонте на станции? ❑ да ❑ нет

В каком ремонте?_____

Имеется ли у организации инвестиционный план? ❑ да ❑ нет

Планируются ли инвестиции в ближайшие два года? ❑ да ❑ нет

Если да, на что будут направлены первоочередные инвестиционные вложения?_____

_____

2) Процесс водоподготовки

Какие технологии очистки включает в себя процесс водоподготовки

- фильтрация через песчаный фильтр ❑
- химическое осаждение ❑
- озонирование/окисление ❑
- фильтрация с помощью активированного угля ❑
- хлорирование ❑
- ультрафиолетовое облучение ❑
- другие технологии, какие?_____

_____

Что удаляется из воды?

- органические вещества / гумус ❑
- металлы ❑
- соли ❑
- бактерии/вирусы ❑
- другое, что?
  _____

- Существуют ли в законодательстве требования к качеству питьевой воды? ❑да ❑нет

Если да, какие требования?_____

_____

Выполняются ли требования? ❑да ❑нет

Параметры очищенной воды:

- органические вещества / гумус ❑
- металлы ❑
- соли ❑
- бактерии/вирусы ❑
- другое, что?
  _____

_____

3) Образование и профессиональная подготовка

Количество сотрудников в организации _____

Количество сотрудников, имеющих:

- Начальное профессиональное образование _____
- Среднее профессиональное образование_____
- Высшее профессиональное образование_____
- Другое _____

Проводилось ли обучение сотрудников? ❑да ❑нет

Если да, где проводилось обучение?

- Непосредственно на станции ❑
- В ГУП «Водоканал Санкт-Петербурга» ❑
- На других городах России, где? _____
- За рубежом, где?_____

Есть ли необходимость в дополнительном обучении сотрудников? ❑да ❑нет

Выделяются ли средства из бюджета организации на обучение сотрудников? ❑да ❑нет

Заинтересовано ли Ваше предприятие в направлении сотрудников на обучение в рамках мероприятий Международного центра передовых водных технологий? ❑да ❑нет

Если да, то в каких?

- В семинарах ❑
- В практическом обучении ❑
- В посещении производственных объектов ❑
- В других мероприятиях (указать тип) _____

По каким темам существует необходимость в дополнительном обучении:

- по технологиям очистки воды ❑
- по поддержанию оборудования в рабочем состоянии и его обслуживанию ❑
- по поддержанию трубопроводов в рабочем состоянии и их обслуживанию ❑
- по автоматике ❑
- по измерительной технике ❑
- по вопросам энергоэффективности ❑
- по вопросам законодательства ❑
- по финансово-экономическим вопросам ❑
- по вопросам оперативно-технического управления ❑
- по вопросам управления организацией ❑
- по вопросам управления персоналом ❑
- по вопросам организации ВКХ ❑
- другие темы (указать)

  _____

  _____

Заинтересовано ли Ваше предприятие заключить рамочное соглашение с ГУП "Водоканал Санкт-Петербурга" на обучение в рамках Международного центра передовых водных технологий?

❑да ❑нет

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