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Background

A list of significant pollution sites around the Baltic Sea – HELCOM Hot Spots –was established in 1992. Three quarters (121 out of 162) have been cleaned up by June 2019.

Riga WWTP has been included in the HELCOM hot spots list due to the large amount of pollution being discharged into the environment due to insufficient treatment of wastewater and a large share of untreated municipal wastewater being released in surface water. During the last 30 years, investments have been made to increase the capacity of Rīga WWTP and wastewater treatment efficiency as well as establish a sewage network covering Rīga and several nearby municipalities.

PRESSURE 13-2020 thanked Latvia for the great work done to reduce nutrient input into the Gulf of Riga and invited Latvia to provide quantified information on the efficiency of the sewage system proving compliance with HELCOM Recommendations before the HOD 59-2020. The Meeting in general agreed that the hot spot can be deleted and recommended HOD 59-2020 to delete hot spot No. 42 Rīga WWTP from the HELCOM list, pending of the submission of the requested information on the sewage system efficiency.

This document contains a justified suggestion on deletion of Rīga WWTP from the HELCOM list of hot spots. Annex 1 present evaluation of the efficiency of the sewage system, requested by PRESSURE 13-2020. The calculation of the efficiency is given in the Attachment to this document in Excel format.

Action requested

The Meeting is invited to agree on deletion of hot spot No. 42 Rīga WWTP from the HELCOM list.

PROPOSAL FOR DELETION OF JCP HOT-SPOT No 42: RĪGA WWTP

Rīga wastewater treatment plant in Daugavgrīva (Rīga WWTP) is one of the largest in the Baltic Sea region (Fig. 1 and 2). It is designed for population equivalent (PE) of 1 030 000. Rīga WWTP has been included in the HELCOM hot spots list due to large amount of pollution being discharged into the Gulf of Riga, and it was necessary to improve WWTP performance (HELCOM, 2001). At the end of 1991, 1st phase of the new biological WWTP in Riga was completed. It greatly contributed to the reduction of loads of organic matter. Input of BOD to the Gulf of Riga was reduced from 35 000 to 1 950 t/y and that of COD from 58 000 to 3 900 t/y (HELCOM, 1993). However, many problems still remained (Pre-Feasibilitry Study..., 1992; HELCOM, 1993; VKMC, 2000; HELCOM, 2002;):

- ✓ efficiency in removal of inorganic forms of nutrients from wastewaters was not in line with HELCOM requirements;
- ✓ high share (40-50 %) of industrial wastewater was discharged into the municipal sewage systems without any pre-treatment creating severe difficulties, in particular interruption of the processes of biological treatment;
- ✓ both wastewater and sludge contained heavy metals in high concentration;
- ✓ connectivity and improvement of sewerage network itself was necessary to prevent discharges of heavy metals, nutrients and other harmful substances in Daugava River and lakes surrounding Riga due to releases of untreated or insufficiently treated wastewater;
- ✓ construction of sludge depository and establishment of composting fields were tasks for nearest future.

Figure 1. Location of Rīga WWTP in Daugavgrīva.

Figure 2. Daugavgrīva biological wastewater treatment plant *(photo "Rīgas ūdens").*

According to "Rīgas ūdens" expert estimations, approximately 27-30% of the total wastewater is generated by industrial companies. Company "Rīgas ūdens" provides sewage services for Riga and partially for nearby municipalities of Ķekava, Garkalne, Mārupe, Stopiņi and Ādaži, and provides wastewater treatment services for the eastern part of Jūrmala municipality. Collected wastewater undergoes mechanical and biological treatment. Wastewater treatment process was significantly improved in 2014, after reconstruction of WWTP. Bio Denitro^{TM} technology was introduced and treatment processes were automated. The introduced technologies allowed to achieve a significant reduction of nitrogen and phosphorus concentration in wastewater.

The residence time of wastewater in biological treatment plant (Fig. 3) is approximately 24 hours – wastewater enters the reception chamber, passes through all the treatment phases, and after the completion of processes treated wastewater is discharged into the Gulf of Rīga at a depth of 15 m and a distance of 2.4 km from the shore.

Figure 3. Wastewater treatment at Daugavgrīva WWTP *(photo F64).*

Dewatered sludge that remains after the wastewater treatment is transported to sludge fields in Vārnukrogs 2104, Priedaine, Jūrmala, or handed over for further management to businesses which have permits for sludge management (B category permit for polluting activity No. RI12IB0013, 2019).

RĪGA WWTP CONFORMITY ASSESSMENT FOR REMOVAL FROM HELCOM HOT SPOT LIST

STEP 1. Evaluate pollution load and water quality downstream of the object

Changes in amount of wastewater

The population connected to Riga WWTP has been relatively stable for the last 10 years - slightly over 620 thousand people. The average PE number in the last 10 years is approximately 660 thousand (Fig. 4). There is a gradual tendency for a total wastewater amount to decrease since 2000 (on average by 0.47 million m^3/y). The total volume of wastewater was almost 60 million m^3/y in 2000, and around 50 million m^3/y in 2016 (Fig. 5). The amount of wastewater per one PE has also a tendency to decrease.

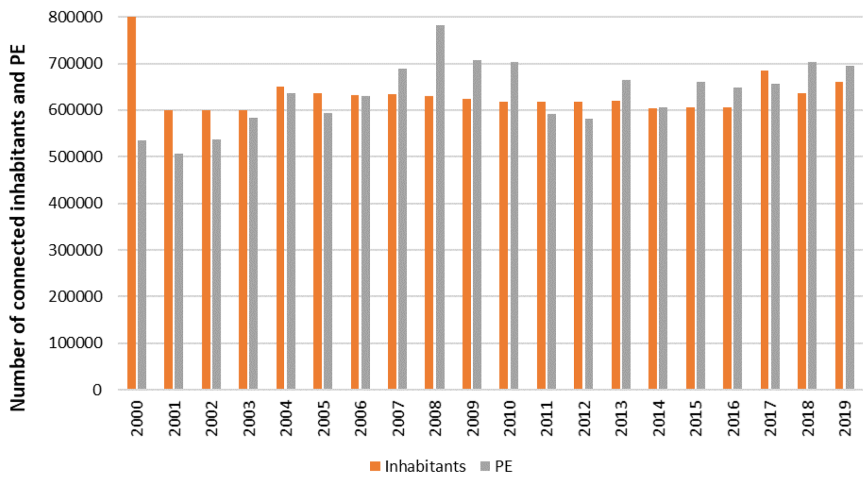

Figure 4. Changes in population and population equivalents connected to Rīga WWTP.

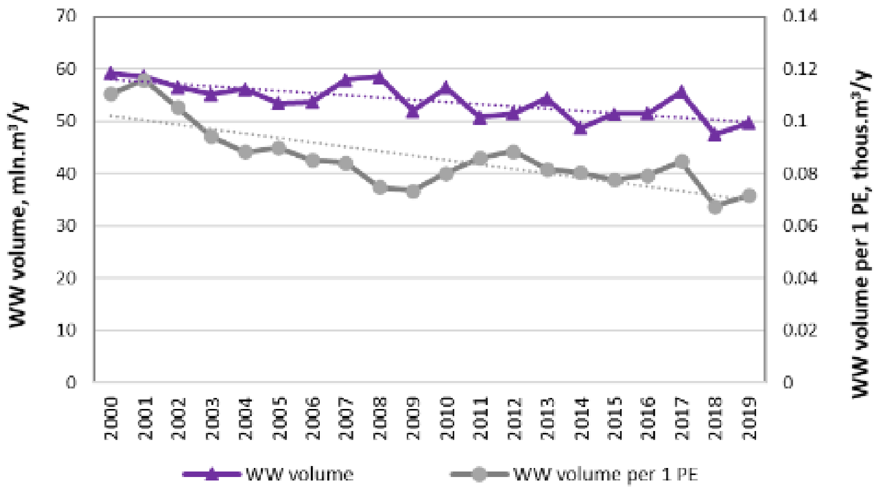

Figure 5. Changes in the total amount of wastewater and the amount of wastewater per 1 PE (thousand m³/year).

Changes in pollution loads discharged into the environment by wastewater

Data on the pollution loads in influents and effluents are obtained from the national statistical report "Ūdens-2".

The largest total nitrogen load (almost 2400 t) was discharged into the Baltic Sea in 2008, before the completion of Rīga WWTP reconstruction. As a result of WWTP reconstruction the load on the Baltic Sea has been reduced more than twice. Substantial reduction of N_{tot} load discharged into the environment was achieved in 2013 and 2014 with the introduction of Bio Denitro™ technology. N_{tot} load discharged into the environment from 2014-2019 varied between 344-484 t/y, while the concentration of N_{tot} was between 6.6-9.4 mg/l (Fig. 6). The concentration of N_{tot} in effluents does not exceed the limit value of 10 mg/l specified in HELCOM Recommendation 28E/5.

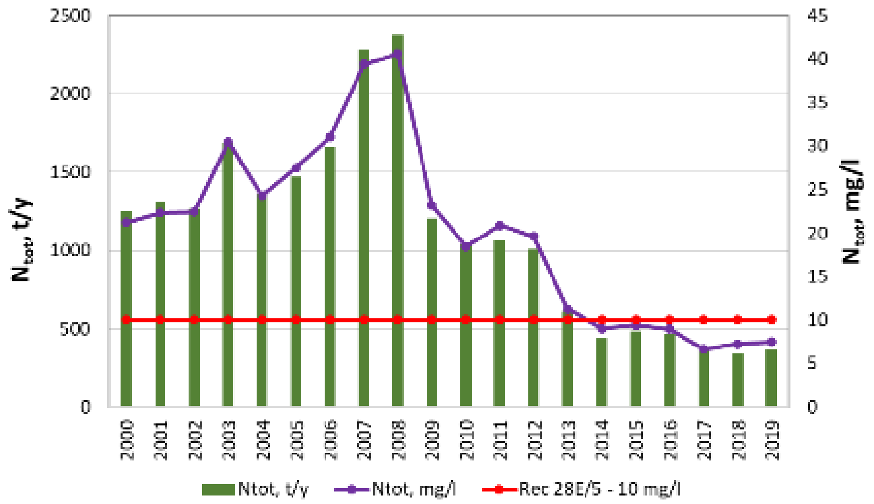

Figure 6. Changes in N_{tot} load (t/year) and concentration (mg/l) in wastewater discharged into the environment from 2000 to 2019. 10 mg/l is the limit value stated in HELCOM recommendation 28E/5 on urban wastewater treatment.

The introduction of Bio Denitro™ technology has allowed to improve the efficiency of Riga WWTP in terms of reducing nitrogen pollution. Since 2013, the efficiency of Rīga WWTP meets the requirements of HELCOM Recommendation 28E/2, where at least a 70-80% reduction of N_{tot} load is required (Fig. 7).

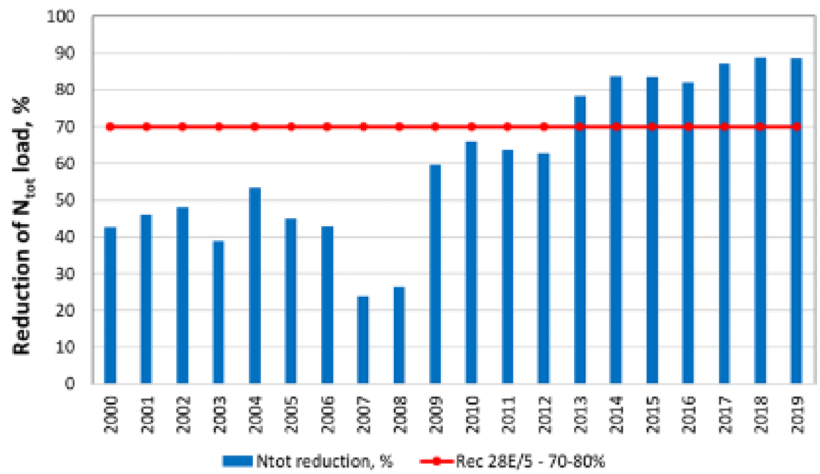

Figure 7. Changes in Rīga WWTP efficiency (%) regarding the N_{tot} load reduction from 2000 to 2019. The reduction of N_{tot} load in HELCOM Recommendation 28E/5 on urban wastewater treatment shall be at least 70-80%.

The most significant decrease in the load of P_{tot} discharged into the environment also took place in 2009 (Fig. 8). Until the completion of the WWTP reconstruction, the average load of P_{tot} discharged into the environment was approximately 170 t/y, but the concentration of P_{tot} in effluents was 3.0 mg/l. In 2012-2015, a slight increase of emitted pollution loads and P concentration in treated wastewater have been observed. A reason for this is the reconstruction of the WWTP when STAR2 Professional® wastewater treatment control system with BioP and simultaneous P precipitation modules were introduced. The reconstruction works have caused a temporary decrease in efficiency of P removal. During the last four years, the average load to the Baltic Sea is 34 t/y, but the concentration – 0.67 mg/l. The concentration of P_{tot} in effluents exceed the limit value of 0.5 mg/l specified in HELCOM Recommendation 28E/5.

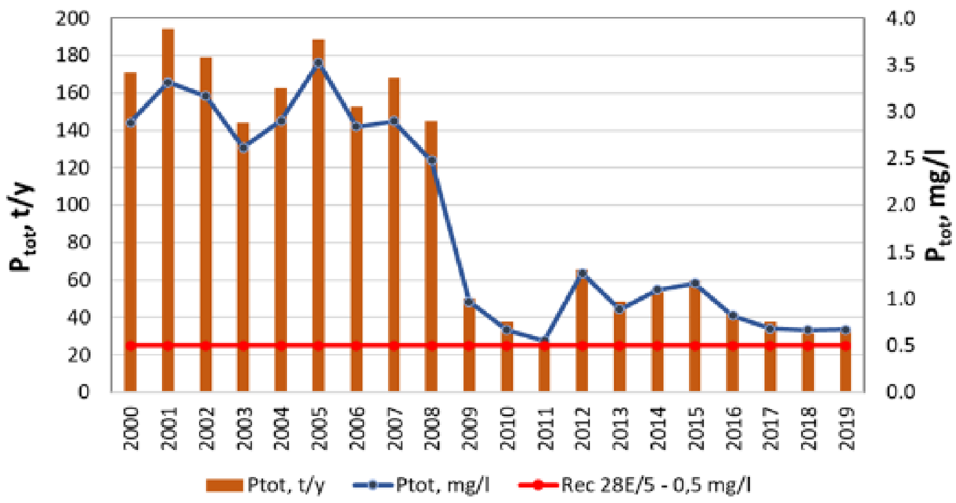

Figure 8. Changes in P_{tot} load (t/year) and concentration (mg/l) in wastewater discharged into the environment from 2000 to 2019. 0.5 mg/l is the limit value stated in HELCOM recommendation 28E/5 on urban wastewater treatment.

The efficiency of the Rīga WWTP regarding the treatment of P_{tot} pollution has improved significantly since 2000 (Fig. 9). Since 2016, efficiency is above 90%. It complies with the requirements of HELCOM Recommendation 28E/5.

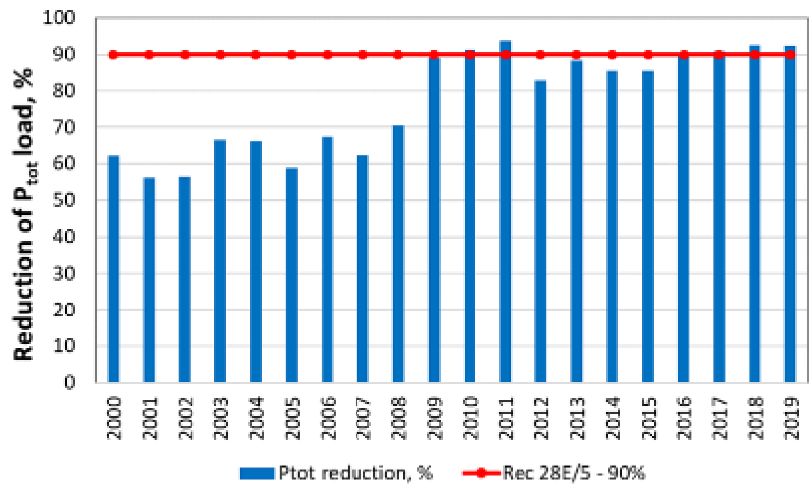

Figure 9. Changes in Rīga WWTP efficiency (%) regarding the P_{tot} load reduction from 2000 to 2019. The reduction of P_{tot} load stated in HELCOM recommendation 28E/5 on urban wastewater treatment should be at least 90%.

Since 2009, the load of easily degradable organic matter discharged into the environment has decreased by approximately 40%. The average BOD_5 load since 2009 is approximately 470 t/y, but the concentration – 9.0 mg/l (Fig. 10). The concentration of BOD_5 in effluents does not exceed the limit value of 15 mg/l specified in HELCOM Recommendation 28E/5. It should be noted that since 2009 the load of organic matter, which is characterized by chemical oxygen consumption (COD), has also decreased by more than 40%. Since 2009, the COD load discharged into the environment is approximately 2200 t/y. COD concentration in effluents is 43 mg/l.

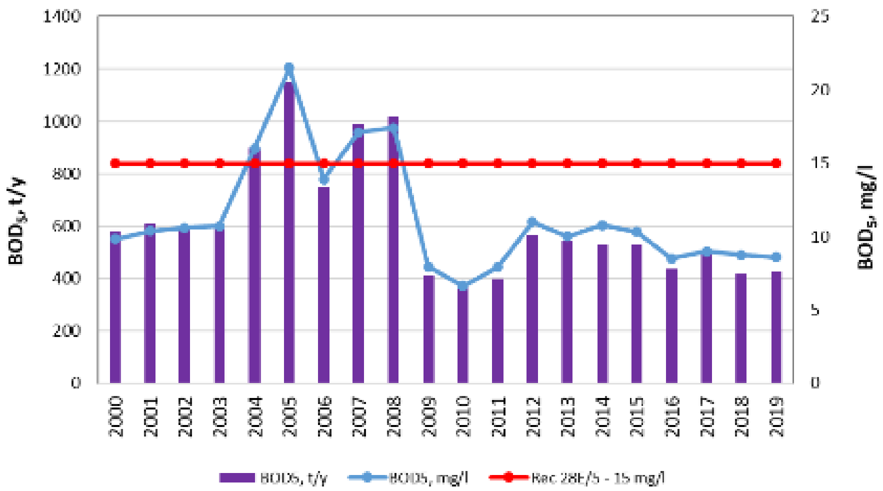

Figure 10. Changes in BOD_5 load (t/year) and concentration (mg/l) in wastewater discharged into the environment from 2000 to 2019. 15 mg/l is the limit value stated in HELCOM recommendation 28E/5 on urban wastewater treatment.

The efficiency of Rīga WWTP in reducing the content of organic matter in wastewater is compliant with the requirements of HELCOM Recommendation 28E/5 since 2000 (Fig. 11). Between 2000 and 2019, the efficiency of WWTP was on average 95% in regards to BOD_5 load reduction.

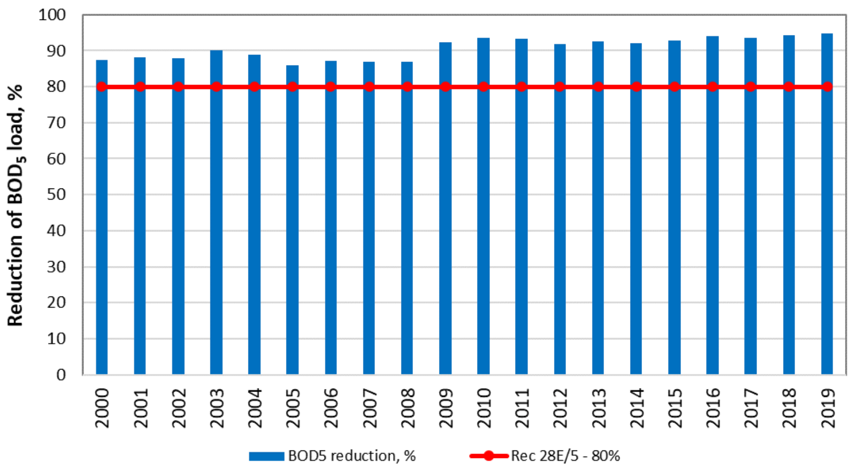

Figure 11. Changes in Rīga WWTP efficiency (%) regarding the BOD_5 load reduction from 2000 to 2019. The reduction of BOD_5 load stated in HELCOM recommendation 28E/5 on urban wastewater treatment should be at least 80%.

Heavy metal loads have also decreased since 2005; the exception is arsenic load, which has no clear trend (Fig. 12).

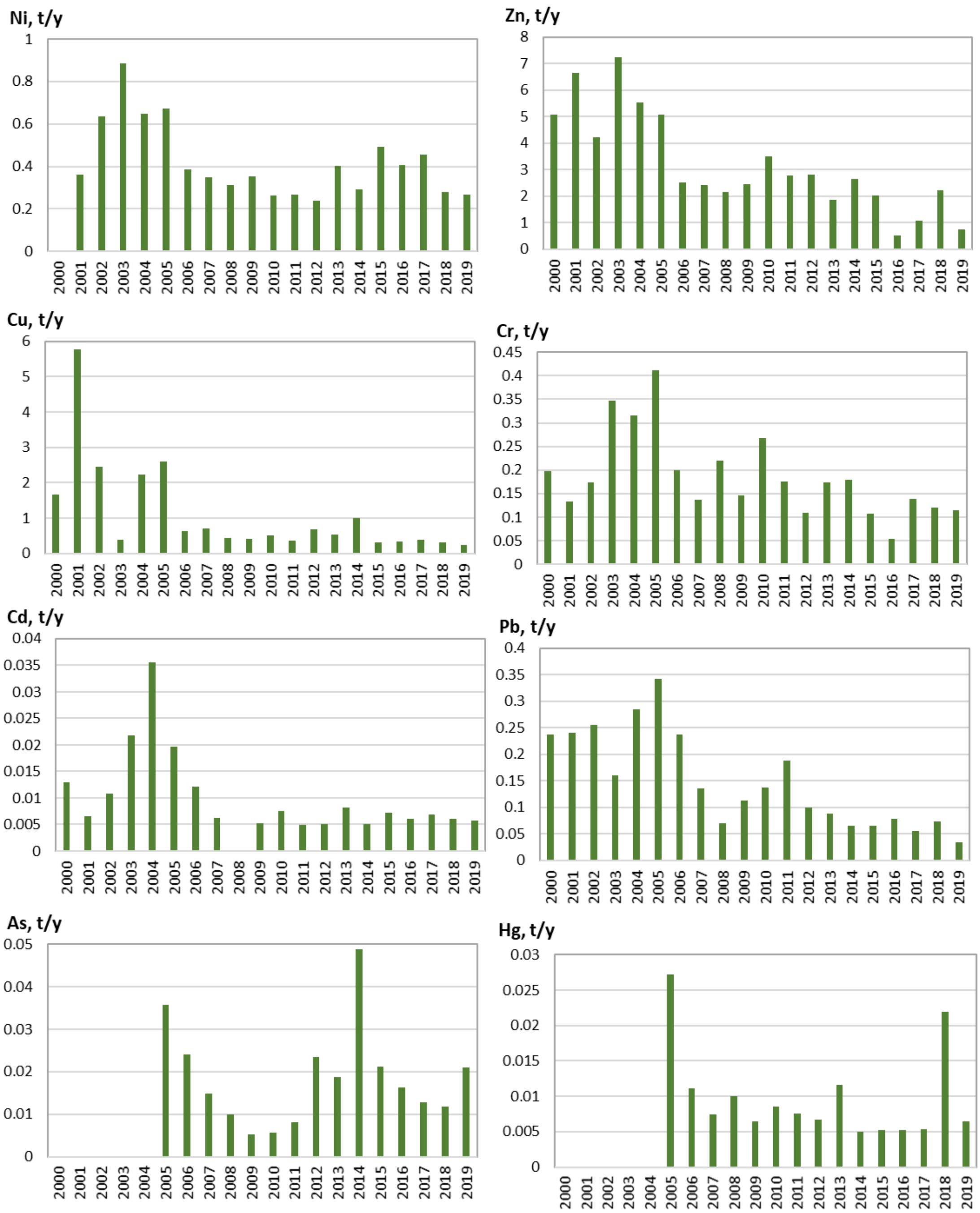

Figure 12. Heavy metal loads discharged into the environment, t/y.

Surface water quality in the receiving water body

Treated wastewater from the Rīga WWTP is discharged to the Gulf of Rīga at a depth of 15 m and a distance of 2.4 km from the shore. According to the B category permit for polluting activity No. RI12IB0013 (2019) the WWTP operator is not required to monitor the physico-chemical quality of surface water in the Baltic Sea near the wastewater discharge site.

The load assessment data (HELCOM, 2018) demonstrate that the N_{tot} load from point sources with discharge into the Gulf of Rīga directly in Latvia and Estonia in 2014, was only 0.6% of the total N load to the Gulf of Rīga. P_{tot} load from direct point sources in 2014 accounted for 2.6% of the total P load. Pollution loads discharged directly into the Gulf of Rīga from point sources in Latvia and Estonia have decreased since 1995 (HELCOM, 2018).

Development of sewerage systems

Direct comparison of temporal changes in pollution loads since early 1990'ies when Rīga WWTP (in Daugavgrīva) was included in the HELCOM hot-spot's list and nowadays is not possible. In 1991, the largest share of wastewater and pollution loads were discharged by sewerage collectors in Vējzaķusala un Hanzas street as well as by WWTP Latgale in Rīga. Nowadays, most of the former outflows are connected to the centralized sewerage system and treated in Rīga WWTP (Daugavgrīva). Several large industrial enterprises (e.g., Rīga porcelain factory, rubber factory "Sarkanais kvadrāts", cement plant "Rīgas cementnieks", Rīga Food Factory) have ceased their production. Other enterprises, e.g., Rīga Milk Factory (now Food Union) most of their untreated wastewater are transferring to Rīga WWTP. Rough estimates (Fig. 13) show wastewater volume have decreased by more than 60 % and pollution loads by about 90 % since 1991.

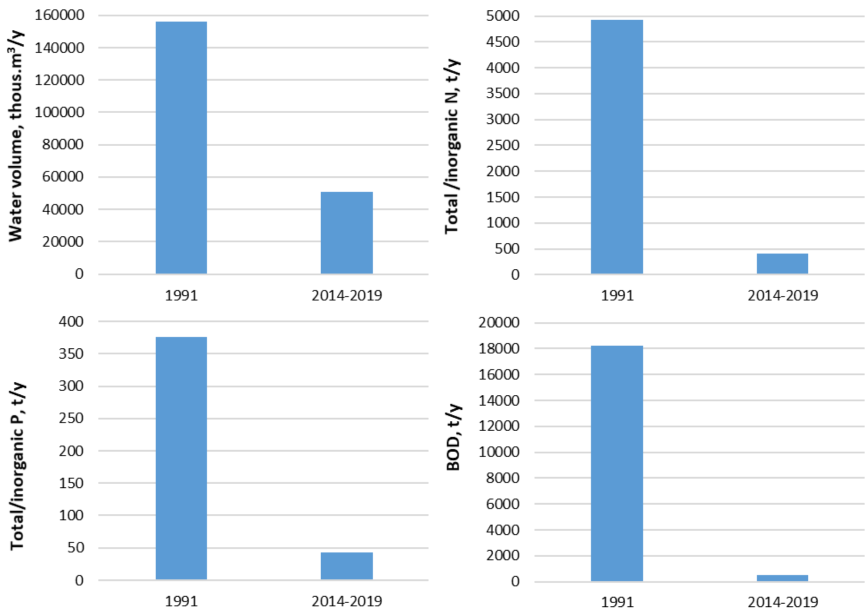

Figure 13. Comparison of pollution loads from 25 outlets in 1991 and Rīga WWTP in 2014-2019. N and P loads in 1991 are inorganic N and P (data sources: Andrušaitis et al 1992; database "Water-2").

Nowadays, wastewater in sewerage network is pumped by 85 sewage pumping stations. There are 22 discharge sites for emergency release of wastewater in order to prevent overload of the WWTP or flooding of the sewerage networks in case of intense rainfall or accidents in sewerage networks. It is prohibited to discharge untreated industrial and domestic wastewater as well as untreated sludge into the environment (B category permit for polluting activity No. RI12IB0013, 2019; Cabinet of Ministers Regulations No 34, 2013). According to the national database “Water-2”, each year 1150 – 2640 thousand m^3 of untreated wastewater and stormwater mixture are discharged into the environment during 2014-2019. That contributes 2-5 % of the total wastewater volume released to the environment.

According to the estimates of company “Rīgas ūdens”, the share of industrial wastewater is 27-30 % of the total volume. The company controls the quality of the received wastewater from industrial enterprises. Strict quality criteria for the received wastewater must be set in an official agreement between company “Rīgas ūdens” and each industrial enterprise. The agreement must also contain criteria for priority and hazardous substances, if an enterprise emits or plans to emit those (B category permit for polluting activity No. RI12IB0013, 2019; Cabinet of Ministers Regulations No 34, 2013). Besides, larger enterprises must have pre-treatment facilities for their wastewater to ensure a proper quality of wastewater prior transferring it to Rīga WWTP.

Handling of wastewater sludge

The volume of sewage sludge produced has increased over the last ten years and it exceeded 45 000 tons of wet sludge in 2019 (Fig. 14).

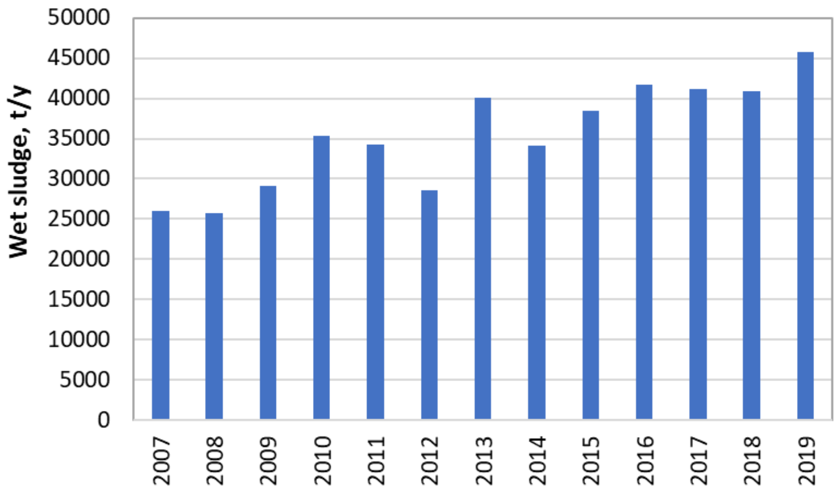

Figure 14. Long-term changes in the mass of wet sludge (t/y) produced by Rīga WWTP.

During the last three years the Zn content in the sludge varied from 924 to 962 mg/kg of dry matter, Cu content – from 289 to385 mg/kg. Cr content during this period of time varied between 63and

85 mg/kg, Cd – between 0.95 and 1.23 mg/kg and Ni –between 26 and 36 mg/kg of dry matter. The content of Pb in the sludge was 24 to 39 mg/kg, and Hg – 1.2 to 1.8 mg/kg of dry matter (Fig. 15).

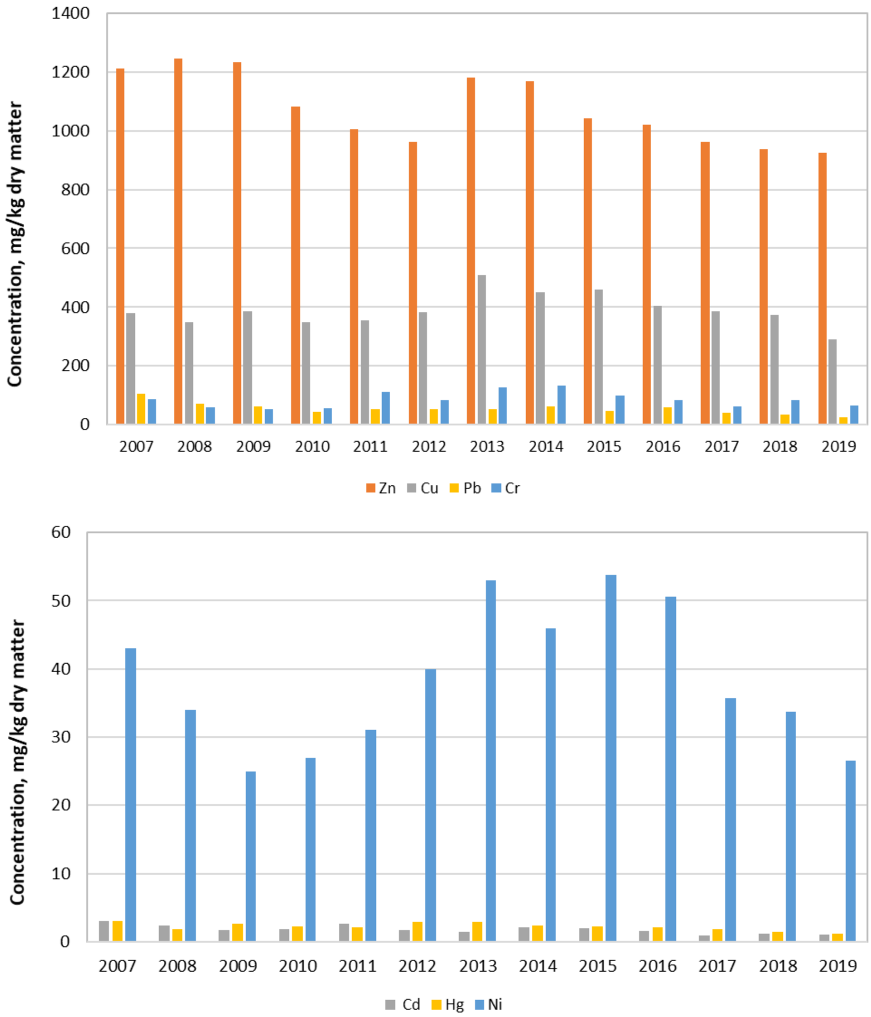

Figure 15. Long-term changes in the heavy metal content in Rīga WWTP sewage sludge.

According to the concentration of these heavy metals Rīga WWTP sewage sludge classifies as sewage sludge quality class 1 (02.05.2006. Regulation of the Cabinet of Ministers No. 362). Such sludge can be used in agriculture and preparation of compost.

The amount of sludge used for composting has increased since 2012, and in 2018 it was more than 26 000 tons of wet sludge or 6195 tons, if converted to dry mass. In 2018, more than 65% of the total volume of sludge produced was composted. Compost production from sludge is performed by company “Eko Terra”. The volume of sludge stored in a temporary storage has also increased, but annual volumes are highly variable. The rest of the sludge is transferred to company “Sabiedrība Mārupe”, where it is used in agriculture (Fig. 16). Sewage sludge produced in 2009-2013 was mainly used in agriculture.

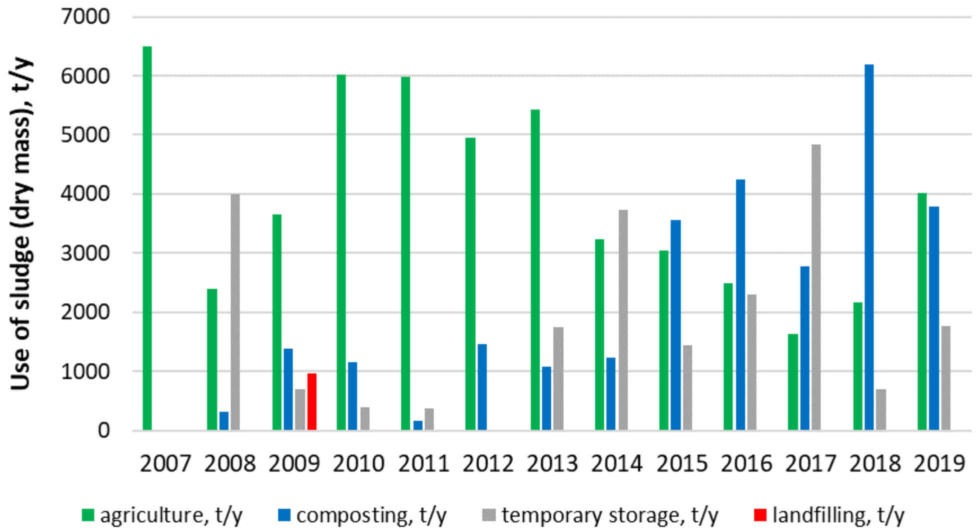

Figure 16. Variability of sludge (dry mass) usage produced by Rīga WWTP.

HELCOM Recommendation 38/1 on sewage sludge handling requires a reuse or recycling of nutrients, especially phosphorus. Average P content in sludge of Rīga WWTP is 28.25 g/kg dry mass (B category permit for polluting activity No. RI12IB0013). More than 50 % of P in sludge are reused in agriculture or sold as a compost (Fig. 17). Although, amount of P in temporary stored sludge is included in a category "P not recycled", it can be used in agriculture or compost production in the next year. In total during period 2007 – 2019, 1455 tons of P were used in agriculture; 772 tons of P were recycled due to production of compost; 621 ton was accounted under the temporary storage and 27 tons of P were landfilled.

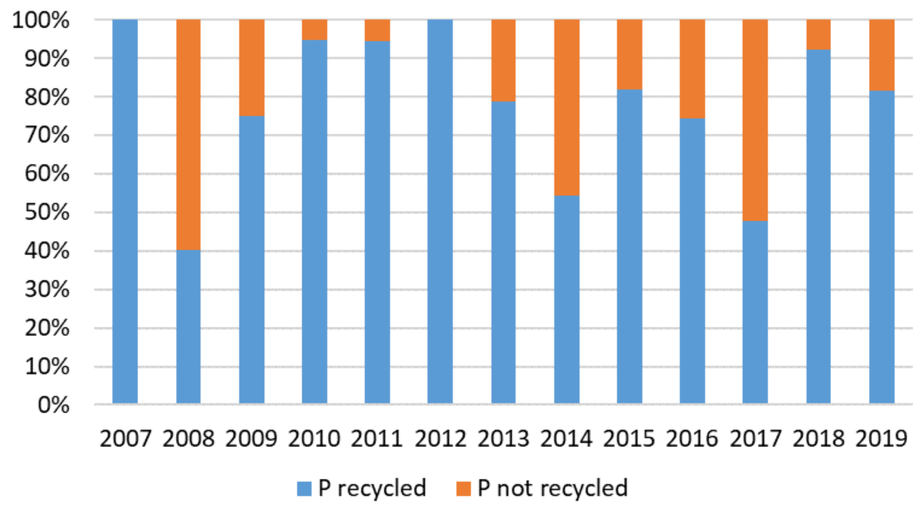

Figure17. The share of recycled phosphorous from sewage sludge.

Wet sludge produced in Rīga WWTP undergoes anaerobic fermentation in a sludge digester. As a result of fermentation biogas is produced. Up to 6.65 mln Nm^3 of biogas per year is transferred to a company "RIGENS" which uses it as a fuel in a co-generation station (4.92 MW).

Sludge from the sludge digestors is transported to sewage fields. Sewage sludge is stored on 9 sludge fields owned by company “Rīgas ūdens”, 4 fields are used by company “Rīgas ūdens”, remaining 5 fields are rented by company “Eko Terra”. Total capacity of these 9 fields is 67 500 m^3. In addition, 2 sludge storage sites with a total capacity of 215 000 m^3 are used.

Treated and fermented sludge from methane tanks of Riga WWTP is transported to 4 sludge fields of company “Rīgas ūdens”. In case the maximum permitted load of the methane tanks is exceeded, excess treated sludge is delivered to the sludge storage facilities. Company “Rīgas ūdens” stores treated and fermented sewage sludge for a period of up to one year.

Sludge treated in methane tanks is also transported to the sludge fields rented by company “Eko Terra”, which produces compost from sludge. Sludge fields are water-impermeable with concrete walls. Drainage waters from the sludge fields are delivered to Riga WWTP for treatment (B category permit for polluting activity No. RI14IB0068, 2014).

In addition to domestic wastewater sludge, which comes from company “Rīgas ūdens”, company “Eko Terra” accepts biodegradable waste, animal feces, urine and stable manure, furnace ash as structural material for compost production. The total amount of materials received may not exceed 70 450 t/year, with a maximum limit set for each waste class. Park and garden waste, and sawdust are also used as structural material in compost production. Up to 60 000 tons of compost can be produced per year (B category permit for polluting activity No. RI14IB0068, 2014). According to the data of the database “3-Atkritumi”, company “Eko Terra” received a total of 28 414 t of waste in 2016, most of which (18 232 t) was sewage sludge. Compost produced by “Eko Terra” is sold as organic fertilizer, which can be used for crop production, organic farming, recultivation of territories, greening, etc.

STEP 2. Monitoring data compliance with the requirements of the HELCOM recommendations and legislation

Quality of wastewater discharged into the environment and efficiency (%) achieved in wastewater treatment plants is compared to HELCOM recommendations 28E/5 on urban wastewater treatment (15.11.2007), as well as Regulation of the Cabinet of Ministers No. 34 (22.01.2002., with the amendment until 22.03.2013), and the limit values specified in the B category permit for polluting activity (Table 1, 2). Cabinet Regulation No. 34 incorporates the requirements of the Urban Wastewater Directive.

Concentration of N_{tot}, organic matter, suspended matter and heavy metals in effluents don't exceed the standards specified in HELCOM recommendations, the regulations of the Cabinet of Ministers and the B Category permit for polluting activity (Table 1). Concentration of P_{tot} in effluents exceeds the limit value specified in HELCOM Recommendation 28E/5 on the limit value set for urban wastewater treatment, however the efficiency of the WWTP surpasses 90 % which is in line with HELCOM requirements. Since 2016 P_{tot} concentration doesn't exceed the limit value of 1.0 mg/l specified in the Regulations of the Cabinet of Ministers No. 34.

Table 1. Pollutant concentration over the last three years and its compliance of with the emission limit values specified in the legislation.

Parameter	2017	2018	2019	HELCOM Rec28E/5	Reg. No. 34	B category permit
N_{tot}, mg/l	6.6	7.2	7.5	10.0	10.0	10.0
P_{tot}, mg/l	0.68	0.67	0.67	0.5	1.0	1.0
BOD_5, mg/l	9.0	8.7	8.6	15.0	25.0	25.0
COD, mg/l	38.6	44.5	41.1		125.0	125.0
Susp.solids, mg/l	8.2	8.5	9.1		<35.0	<35.0
Zn, mg/l	0.02	0.05	0.01			0.2
Cr, mg/l	0.003	0.003	0.002			0.05
Cu, mg/l	0.007	0.007	0.005			0.2
Ni, mg/l	0.008	0.006	0.005			0.05
Cd, mg/l	0.00012	0.00012	0.00011			0.02
Pb, mg/l	0.0010	0.0015	0.0007			0.05
As, mg/l	0.0002	0.0002	0.0004			0.02
Hg, mg/l	0.0001	0.0005	0.0001			0.02

Data for the years 2017 - 2019 show efficiency of Riga WWTP in reducing concentration of N_{tot}, P_{tot}, organic matter, and suspended matter in wastewater (Table 2), which is in line with both international and national requirements. The efficiency of Riga WWTP meets HELCOM requirements.

Table 2. Efficiency of Rīga WWTP (%) and its compliance with HELCOM and national requirements.

Parameter	2017	2018	2019	Rec28E/5	Reg. No. 34	B category permit
N_{tot}	87	89	89	70-80 %	70-80 %	70-80 %
P_{tot}	91	92	92	90 %	80 %	80 %
BOD_5	97	97	97	80 %	70-90 %	70-90 %
COD	94	94	95		75 %	75 %
Suspended solids	97	98	98		90 %	90 %

STEP 3. Assessment of site clean-up effects and monitoring programmes

Riga WWTP is the largest in the Baltic States. Major investment projects have been carried out since the 1990s to improve the efficiency and prevent the release of untreated wastewater into the environment. Implementation of environmental projects contributed to Riga WWTP modernization - phosphorus sedimentation facilities, sludge dewatering storage, and composting area were built, new connections to the WWTP were created, resulting a significant reduction of nutrient concentrations in wastewater.

From 2000 to 2007, the 2nd stage of the project "Development of water services in Rīga" was implemented with Cohesion Fund (program ISPA) contributing EUR 20 721 825. Wastewater management infrastructure in Riga was reconstructed and built within the project.

From 2006 to 2009, the 3rd stage of the project "Development of water services in Rīga" was implemented with a total funding of EUR 81.2 million. Separate systems for municipal wastewater and rain water were built in several districts of Riga (Teika-Čiekurkalns), pipeline reconstruction and expansion of systems water supply and sewerage systems were accomplished in two districts of Rīga (Šampēteris and Dārzciems), new sewerage collectors were constructed, etc. (Venteko, 2008; www.rigasudens.lv).

From 2011 to 2015, the 4th stage of the project "Development of water services in Rīga" was implemented with a total funding of EUR 57.2 million. Main focus of project was on the expansion of systems for water supply and sewerage, as well as reconstruction of drinking water treatment plant "Baltezers", rather than improving the operation of the WWTP (www.rigasudens.lv). Reconstruction of Riga WWTP was completed in 2014. BioDenitro^{TM} technology and automated processes were introduced, leading to significantly improved treatment process and reduced nitrogen and phosphorus compounds in treated wastewater.

From 2010 to 2012 company "Rīgas ūdens" participated in the PURE project, which was co-financed by the Baltic Sea Region Program 2007-2013. Within the project, wastewater flow meters and dosing equipment for chemical precipitation of phosphorus were purchased. In 2012 new centrifuges for sludge dewatering were installed (http://www.purebalticsea.eu).

The analysis of data from "2-Ūdens" national database shows that N_{tot} concentration and WWTP efficiency complies with national and international requirements since 2014. Requirements for P_{tot} are met since 2016.

Quality of influents as well as effluents discharged into the Gulf of Riga is monitored by Wastewater Quality Control group in "Rīgas ūdens" laboratory. An automated sampler for treated wastewater is installed in the contact tanks. A wastewater flow meter is installed before the outlet to the Gulf of Riga. B category permit for polluting activity No. RI12IB0013 (2019) states that the WWTP operator must carry out monitoring of the wastewater before and after the treatment. Parameters to be analyzed and sampling frequencies are as follows:

- ✓ once a week: suspended matter, COD, BOD_5, P_{tot}, N_{tot}, cationic and non-ionic surfactants, N/NH_4^+, N/NO_2^-, N/NO_3^-, phosphates, petroleum products, phenols, formaldehyde, pH;
- ✓ once a month: Zn, Cd, Cu, Ni, Cr, Pb, Hg, As.

The WWTP operator is not required to perform water quality monitoring in the receiving water body (the Gulf of Riga).

CONCLUSIONS

As a result of investments in the water supply and sewerage sector, the **total phosphorus concentration** in wastewater discharged into the environment meets national requirements of the Regulation of the Cabinet of Ministers No. 34 since 2016. The **P_{tot} reduction efficiency** achieved by WWTP (%) meets the requirements of national and EU legislation, and the requirements of HELCOM since 2016. Paragraph 5 of the HELCOM Recommendation 28E/5 states that WWTPs with more than 100 000 PE must achieve at least 90% efficiency by reducing the load of P_{tot}, or the concentration of P_{tot} in effluents must be below 0.5 mg/l. Efficiency of Riga WWTP exceeds 90% of P_{tot} load reduction, aligning with HELCOM requirements.

N_{tot}, organic matter, and suspended matter concentrations in the effluents comply with both national and HELCOM requirements.

Concentrations of heavy metals in sludge are low and corresponds to the highest quality class (Class 1). It is allowed to use such sludge in agriculture and for preparation of compost. Sewage sludge handling is in line with HELCOM recommendation 38/1:

- ✓ largest part of sludge is used in agriculture and composting, thus contributing to recycling of nutrients, especially phosphorus;
- ✓ surface runoff from sludge fields with impermeable surface is collected and transferred back to Rīga WWTP thus preventing leakages of nutrients and other pollutants to soil and groundwater;
- ✓ Gas produced via anaerobic sludge digestion is collected and used in a co-generation station.

<u>Riga WWTP complies with the national and international environmental quality criteria. Latvia will initiate the deletion of the Riga WWTP from the HELCOM hotspot list.</u>

References

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Annex 1

Estimates of the efficiency of Rīga WWTP when taking into account overflow loads

According to the national database "Water-2", each year 1150 – 2640 thousand m^3 of untreated wastewater have been discharged into environment during 2014-2019. This discharge contributes 2-5 % of the total wastewater volume released into the environment. Currently there is no reliable data on chemical composition of the untreated wastewater discharged into the environment during storm events. According to the information received from the State Environmental Service, starting from August 2020 company "Rīga water" will sample wastewater for chemical analysis in four different locations. At the largest overflow discharge site "Voleri" wastewater samples will be collected during each overflow event. For other sites the planned sampling frequency varies from 1x/year to 1x/month.

We used two scenarios to estimate the impact of overflow load on the efficiency of Rīga WWTP.

1) Worst case scenario – TN and TP concentration in the overflow is the same as in untreated wastewater.
2) Dilution by rainwater is accounted – according to the information received from the State Environmental Service, the share of rainwater in the overflow is on average 75 % (70-80%). We assume the untreated sewage is diluted by rainwater with TP concentration 0,27 mg/L and TN concentration 2,0 mg/L. These assumptions are based on Pistocchi A., 2020. doi: 10.1016/j.envres.2020.109129 (Table 2)

The data shows that treatment efficiency is increasing for both TN and TP.

During the last 3 years, the efficiency of Rīga WWTP in respect to TP is:

- ✓ 87 – 88% - worst case scenario
- ✓ 89 – 90 % - if dilution by rainwater is accounted

During the last 3 years, the efficiency of Rīga WWTP in respect to TN is:

- ✓ 83 – 84% - worst case scenario
- ✓ 86 – 87 % - if dilution by rainwater is accounted

Detailed information and calculation are available in Excel file: Riga WWTP_overflow estimates.xlsx