WISA
Water Innovation System Amplifier

Interreg
South Baltic

EUROPEAN UNION
European
Regional
Development
Fund

Report 3.1

Project WISA

Report on the existing stormwater management practices in South Baltic region seaports.

PROJECT WISA

BACKGROUND

WISA (Water Innovation System Amplifier) is a 3-year project that will contribute to a cleaner Baltic Sea by developing and testing new green technologies to reduce pollution by stormwater from ports and other large hard surfaces.

The Baltic Sea is one of the world's most polluted seas. More than 45 million tonnes of fertilizer pass through the ports of the Baltic Sea annually, and the handling contributes to the release of fertilizers and nutrients into the stormwater. This leads to eutrophication with extensive algal blooms and dead seabed.

The main challenge addressed by the WISA project is handling pollutants in stormwater in seaport areas around the South Baltic Sea region. To be able to develop and test new green technologies, in order to reduce pollution discharges we first need to know what is handled and what is in the stormwater. This knowledge will contribute to sustainable development, especially ecological, but also economic as well as social development.

The well-being of the Baltic Sea is a common challenge that needs to be solved in collaboration and in a broad partnership. The project is funded by Interreg South Baltic, and partners in the project are the Port of Åhus, Klaipeda University, Gdansk University of Technology, and Port of Gdynia Authority S.A. Krinova Incubator & Science Park is project owner with a coordinating role.

The project will use the water testbed WISA, where the concept is to use existing infrastructure as a “real life” test environment. In the innovation work, collaboration with various companies and researchers is key to solving the stormwater challenges.

REPORT PURPOSE

The main objective of Work Package 3 is to assess and learn more about current stormwater management in project partner’s seaport areas. In this first project phase (Co-learn), existing technologies for handling stormwater have been assessed. The work is done in close collaboration among project partners and includes assessment of existing situation – collection and summarizing of available statistical and other information on existing practices of stormwater management. This includes both administrative set-up and technical solutions. The research material will be used as a basis for future project phases.

ASSESSMENT IN DIFFERENT PORTS PROVIDES AN EXTENSIVE MATERIAL

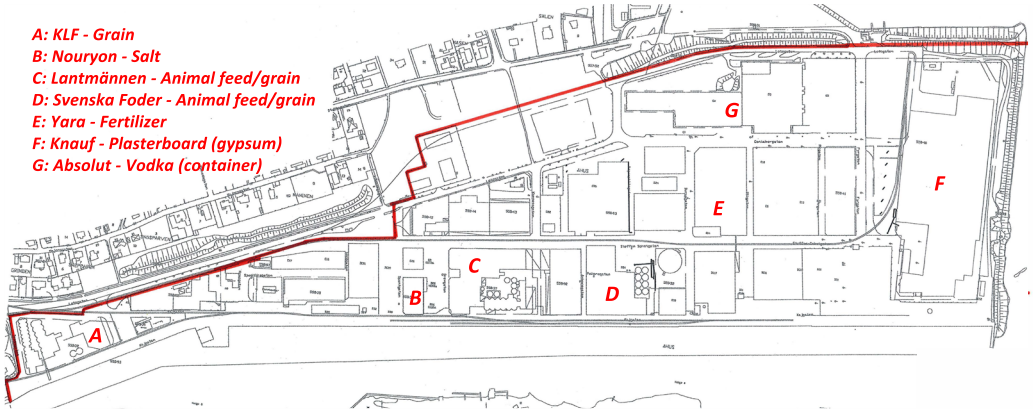
This report includes assessment of current stormwater management in project partner's ports; Port of Åhus in Sweden, Port of Gdynia in Poland and Port of Klaipeda in Lithuania.

These ports, all included in the WISA project, differ in both size and condition, and consequently the assessment of handling methods generated results from different types of ports. A mixture of advanced and simpler techniques is included in this report, and it presents both preventive measures and hands-on methods for purifying stormwater. In addition, the selection of the existing techniques examined is varied. Altogether, the assessment result provides the project with a good idea of the current status and an extensive basis for future work.

EXISTING STORMWATER MANAGEMENT PRACTICES IN PORT OF ÅHUS, SWEDEN

GENERAL INFORMATION, PORT OF ÅHUS, SWEDEN

The Port of Åhus is one of the most important bulk harbours in southern Sweden and the largest container harbour in south-east Sweden. The main business areas are bulk and container handling as well as store leasing. Bulk handling accounts for around 70% of the total volume handled. Port of Åhus is primarily a harbour for import. The imported bulk cargo consists of gypsum, fertilizers, and raw material for animal feed.



The picture shows companies established in Port of Åhus. Åhus Hamn & Stuveri is the owner of several warehouses and facilities and are running the loading/unloading operations in the harbour.

Usually, only unloading of bulk goods takes place in Port of Åhus. The loading that is performed is mainly containers, therefore the port does not have to take any loading problems into account. In terms of volumes and compared to the other ports in the WISA project, Port of Åhus can be considered as a small harbour. Approximately bulk cargo volumes presented below.

	2019	2018	2017
Gypsum	150 000	165 000	175 000
Fertilizers	100 000	95 000	85 000
Raw feed	150 000	175 000	140 000
Cereals	50 000	40 000	40 000
Other	35 000	40 000	35 000

Bulk cargo in metric tonnage.

STORMWATER DRAINAGE AREAS AND NETWORK

Port of Åhus has good knowledge of how stormwater flows in the port area. A tool is created to calculate the pollution from the port area. The calculation is based on measured values from certain outlets and estimates from outlets not possible to measure. Port of Åhus has identified the areas that contribute most to the pollution of the recipient.

During the process a drainage plan has been identified. There are 19 outlets from the harbour area. For several reasons all outlets have not been possible to analyse e.g., hard to find a sample well close to the end pipe not impacted by incoming seawater. Or hard to find a quiet area in the harbour to place the automatic sampler.

Picture below shows an overview of the drainage plan, and which area is connected to the outlets. The outlets are numbered, and the connected area is coloured. There are 19

outlets in total and 17 of them ends in the harbour basin. Number 1-17 from left to right, 18 east and 19 north of the port area. Measurement is made in outlet 8, 11, 13, 17 and 19, close to the end-pipe. The area connected to outlets 8-13 cover almost all bulk handling in the harbour.

Pollution from analysed outlets is calculated based on analysis result, area, and annual rain. Pollution from other outlets is estimated. Estimation in an area is based on type of operation, intensity of operation, result from nearest controlled outlet and wind direction from this one. Wind direction has an impact, especially in bulk handling of light goods.

Stormwater drainage area plan.

MONITORING AND ASSESSMENT

Currently (December 2020), the stormwater leaves the area Port of Åhus untreated, meaning that the water does not undergo any purification. In Port of Åhus, the focus has so far been on preventive measures.

Stormwater is one of the environmental issues that must be investigated to get the operating license approved. By doing some controls and analysis, the annual pollution was calculated. In the total harbour area, the annual pollution in 2013 was as described below.

COD	BOD	N	P	Pb	Cd	Cu	Cr	Zn
33000	6250	3400	500	1,7	0,03	3,5	0,7	60

Annual pollution 2013 in kg.

STORMWATER POLLUTION REDUCTION MEASURES

Historically, attempts have been made to improve cleaning in the harbour area. Some progress was made, but not with enough satisfying results.

During 2017-2020, the preventive work was resumed, and a new successful process was introduced. A common stormwater group was formed with participants representing all the companies in the harbour area. Port of Åhus was the coordinator and several different actions were taken and implemented. Examples presented below.

OPERATOR STORMWATER/DUSTING EDUCATION

- Education of labour to improve knowledge of products environmental impact on stormwater in their handling.
- Education on how to avoid spills of both liquid and solid materials.

CLEANING

- New process for cleaning in port areas
- New and more efficient cleaning equipment used
- More frequent and better cleaning at all companies

SPILLAGE REDUCTION/FILLING LINE IN CRANE BUCKET

- Focus on crane operators to reduce spillage.
- Mark the level to fill in both grab buckets and receiving hopper
- Control leaks from equipment, buckets, conveyers, transport trucks

In addition to these stormwater pollution reduction measures, Port of Åhus also introduced Environmental monitoring with individual meetings with the companies in the harbour area.

The work continues, and next step planned is further improvements in handling of goods. Also, in specific areas, to implement filtration directly in the gutter wells, and to build a sedimentation and filtration unit for purification of the most polluted stormwater.

In order to be able to check pollutants in the stormwater, automatic sampling is used and analysed regularly.

ASSESSMENT OF STORMWATER STATUS

All the prevention measures described have provided good improvements, see results in table below. The focus has been on nitrogen and phosphorus which has been reduced by 60-70%. Metals reduced by 30-40% and oxygen demand by 50-60% between 2013 and 2020.

	COD	BOD	N	P	Pb	Cd	Cu	Cr	Zn
2013	33000	6250	3400	500	1,7	0,03	3,5	0,7	60
2019	14800	1900	1100	170	0,4	0,02	1,5	0,3	30
2020	12000	2100	900	150	0,4	0,02	1,4	0,3	22

Annual pollution in kg.

EXISTING STORMWATER MANAGEMENT PRACTICES IN PORT OF GDYNIA, POLAND

GENERAL INFORMATION, PORT OF GDYNIA, POLAND

The Port of Gdynia is one of the biggest ports in Poland among Gdańsk and Szczecinand Swinoujscie. Gdynia is a multipurpose port specialising in handling general cargo, especially unitized cargo transported in containers and in a ro-ro system.

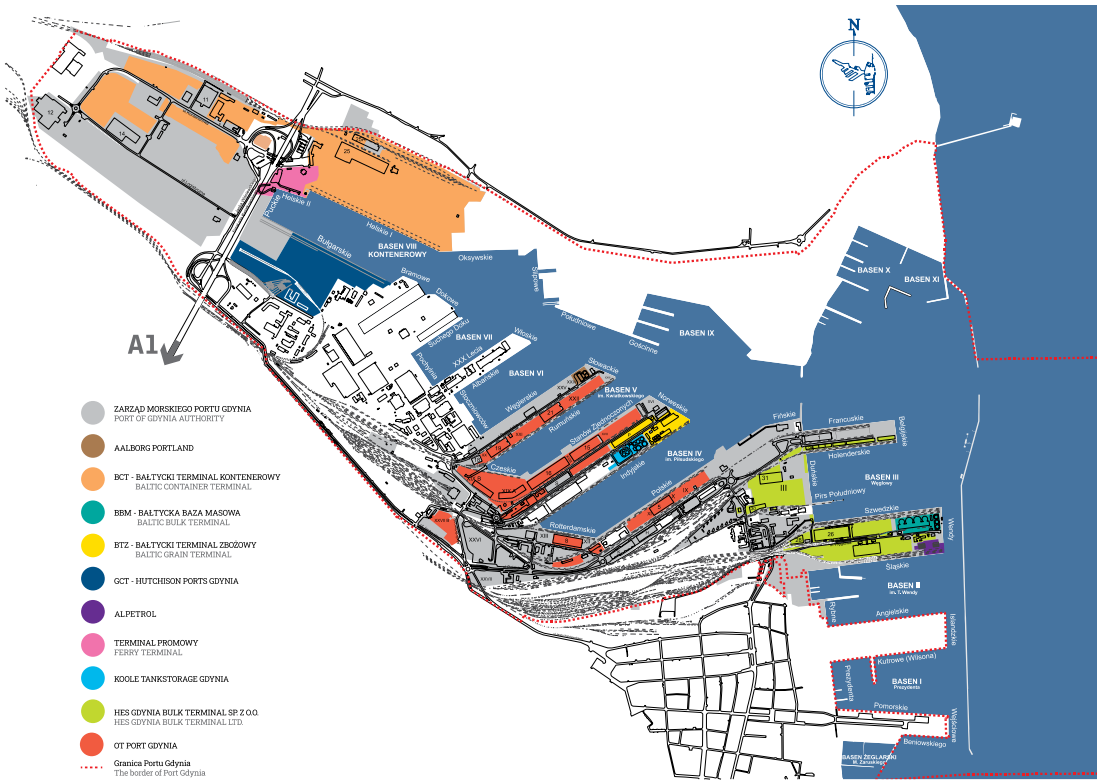
Gdynia has become the leader in grain and fodder handling in Poland. Handling operations in the cargo area are carried out by Baltic Grain Terminal (BTZ), Gdynia Maritime Bulk Terminal (MTMG) and OT Port Gdynia Terminal.

The Port of Gdynia is a logistic hub in the Trans-European Network Transport (TEN-T) and a point of entry to the Baltic-Adriatic Transport Corridor. The Gdynia - Karlskrona 'Motorway of the Sea' is operated by Stena Line and a natural continuation of this corridor to Scandinavia.

Gdynia port has also a modern ro-ro terminal with a two-level ramp for handling the largest ro-pax vessels.

Port of Gdynia Authority is responsible for construction, reconstruction, maintenance and modernisation of port infrastructure, management of all land and port infrastructure located within the administrative jurisdiction of the port; ship waste collection and management etc.

The quays at the Port of Gdynia are 17,700 meters long, of which over 11,000 are used for handling operations. The total area of the port: 973 hectares, including the land area of 621 hectares. Total length of the stormwater system is equal to 27 km, and in the system is also one retention tank.



Map Port of Gdynia.

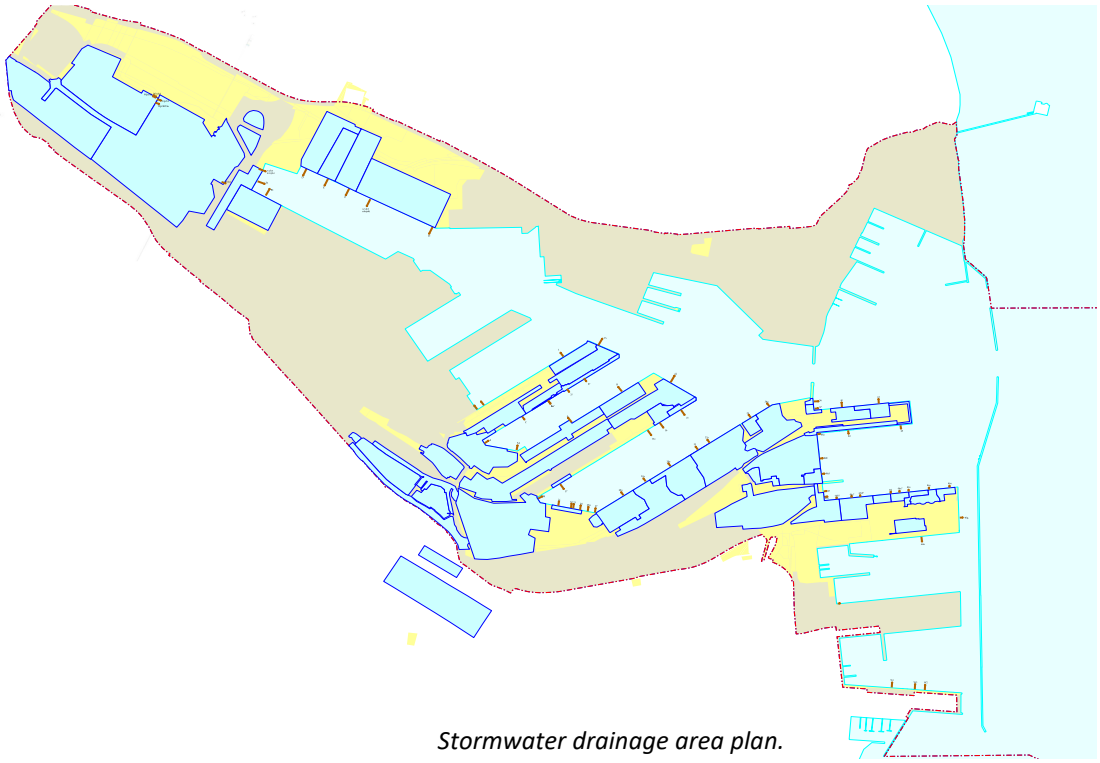
Container handling is carried out by two container terminals located in the western part of the port: Baltic Container Terminal owned by International Container Terminal Services (ICTCI) and the Gdynia Container Terminal (GCT) owned by Hutchison Port Holdings. Additionally, the western part is also dedicated to the development of

intermodal and logistic operations. The main aim in the port's development strategy is the transformation from a feeder port to a container hub and ocean port. Another important segment of the port's operation is bulk cargo handling through specialised terminals.

THE REVOLUTION OF POLISH WATER LAW

Since July 2017 the new rules of Polish water law totally has changed management of environment. The changes in the new polish act are extensive. The authority of the whole water management in Poland is now called Polish state water enterprise – in short „Polish water". The institute regulates the water services which includes e.g:

- Abstraction of ground water or surface water
- Storage of retention of ground water or surface water
- Waste water collection and treatment
- Discharging into water – rainwater, thaw water or snowmelt water to domestic rainwater system



Stormwater drainage area plan.

STORMWATER DRAINAGE AREAS AND NETWORK

The areas are divided by rainwater flows, with drain water from roofs, parking lots, paved squares and green areas. The flows are collected in water basins. Usually, rainwater collects pollutants for further release in the natural environment. In Port Gdynia there are 64 catchment areas with 64 outlets. To each of them Port Gdynia has water permits issued by Polish State Water Enterprise.

MONITORING AND ASSESSMENT

The most polluted areas of Port of Gdynia are the areas with organic loading called Baltic Grain Terminal and Baltic Bulk Terminal. Baltic Grain Terminal offers transhipment and temporary storage of grains, oilseeds and soybean meal.

The stormwater flow in port devices is calculated by the formula $Q = \psi \cdot I \cdot A$

Ψ = run-off coefficient
I = intensity of rain [dm3/s ha] – usually taken from Meteorology Institute
A = catchment area [ha]

Water fees are calculated based on the amount of rainwater.
Example below how to calculate water flow in devices.
Outlet 21, Permit number - DROŚ.A.AW.AW.6220-466

	Roof slope above 15 %	Roof slope below 15 %	Concrete surface	Garden	Sidewalk
	0	3850	3444	0	
	0	0.8	0.9	0	0
Coefficient	0	3080	3099.6	0	0
	SUM of reduced area			6179.6	
	Inensity of ranifall			0.125	
	Discharging rainwater from the catchment area			772.45	

The price per m^3 is equal 0,75 zł. In this example = 772,45 m x 0,75 zł = 579,33 zł (135 euro). By year – 151 000,00 euro for all.

Authority of Port of Gdynia has separate water law permit for each outlet. Usually, issued every 10 years by Polish Water Government for discharging the rainwater or snowmelt water into domestic systems.

- Maximum pollution concentration rates in each water law permit:
- Suspended oil ≤ 100 mg/l
- Hydrocarbons of petroleum origin ≤ 15 mg/l

ASSESSMENT OF STORMWATER STATUS

By law, rainwater must be inspected twice a year. There are specific conditions for each outlet and catchment area on each water-law permit. The results below show that the Mineral Oil Index ranged from <0.1 mg / l to 6.3 mg / l, the total suspension ranged from <2 mg / l to as much as 34,000 mg / l, which meant that the permissible concentration was exceeded. The value of substances extracted with diethyl ether ranged from 0.001 mg / l to 188 mg / l. In some cases, ammonium nitrogen was tested, ranging from 0.3 mg / l to 49.1 mg / l. Research shows that the quality of rainwater varies with the type of pollution carried from the wharfs. The status of the water quality is described as good, but there are sudden exceedances.

Sampling point	Mineral oil index	Total susp. solids	pH	T	Substan.extrac. petroleum ether	N-NH4	Sampling point	Mineral oil index	Total susp. solids	pH	T	Substan.extrac. petroleum ether	N-NH4
	mg/l	mg/l		C	mg/l	mg/l		mg/l	mg/l		C	mg/l	mg/l
wylot nr 1	0,2 - 2,2	4 - 128	-	-	0,001 - 32	-	wylot nr 34	-	35 - 75	-	-	0,1213 - 0,8521	-
wylot nr 2	0,3 - 2,4	10 - 7	-	-	1,8 - 31	-	wylot nr 34a	-	8 - 42	-	-	0,0014	-
wylot nr 3	<0,2 - 0,6	9 - 40	-	-	2,8 - 15,4	-	wylot nr 36	-	6 - 92	-	-	0,0018	-
wylot nr 3a	0,6 - 0,8	5 - 53	-	-	0,001 - 25	-	wylot nr 37	-	7 - 16	-	-	0,0016	-
wylot nr 4	brak	19	-	-	-	-	wylot nr 39	-	12 - 13	-	-	0,008	-
wylot nr 5	0,3 - 6,3	8 - 85	-	-	1,2 - 6,6	-	wylot nr 40	-	9 -21	-	-	0,0026	-
wylot nr 6	1,1 - 3,9	5 - 60	-	-	0,4 - 3		wylot nr 41	-	10 - 32	-	-	0,0025	-
wylot nr 7	-	5	-	-	-	-	wylot nr 43	-	256	-	-	-	-
wylot nr 8	-	78	-	-	-	-	wylot nr 44	-	44 - 58	-	-	0,0126	-
wylot nr 9	-	83	-	-	-	-	wylot nr 44a	-	27 - 77	-	-	0,2458	-
wylot nr 9a	-	28,5	-	-	-	-	wylot nr 44b	-	7 - 25	-	-	0,0169	-
wylot nr 10	-	7	-	-	-	-	wylot nr 44c	-	12 - 48	-	-	0,0958	-
wylot nr 11	-	6	-	-	-	-	wylot nr 44d	-	23	-	-	0,0168	-
wylot nr 12	<0,1 - 2,13	3,4 - 388	6,9 - 7,6	4 - 15,6	1,3 - 11	<0,5 - 35,7	wylot nr 45	-	3 - 21	-	-	0,0068	-
wylot nr 12/13	-	18 - 56	-	-	0,001 - 0,09	-	wylot nr 46	< 0,1	42,0	6,8	15,0	-	-
wylot nr 13	-	45,5	-	-	-	-	wylot nr 46a	<0,1	12 - 129	6,8	5,3 - 15	0, 0095 - 4,6	-
wylot nr 14a	<0,2 - 0,4	12 - 210	-	-	2,2 - 35	4	wylot nr 46b	-	6 - 218	-	-	0,0018 - 5,6	-
wylot nr 15	<0,2 - 0,7	7 - 1000	-	-	0,016 - 8	1,9 - 49,1	wylot nr 46c	1,9	13 - 224	-	-	0,0986 - 3,6	-
wylot nr 16	<0,2 - 0,66	7 - 270	-	-	0,008 - 5,68	0,3 - 28,2	wylot nr 46d	2,7	46 - 195	-	-	0,1698 - 3,2	-
wylot nr 17	0,2 - 0,78	5 - 200	-	-	0,005 - 3	-	wylot nr 46e	<0,2 - 0,8	16 - 440	-	-	0,095 - 5,2	
wylot nr 18	0,6 - 2	9,5 - 210	-	-	1,2 - 3,2	-	wylot nr 46f	<0,2	4	-	-	-	-
wylot nr 19	<0,2 - 0,6	21,5 - 110	-	-	0,6 - 2,6	-	wylot nr 46g	<0,1 - 1,5	2,7 - 182	6,9 - 7,6	4,5 - 14,1	0,0369 - 11,4	-
wylot nr 20	<0,2	10 - 47	-	-	0,0125 - 2,4	-	wylot nr 46h	<0,1 - 3	4 - 1500	7,3	11,9	0,0098 - 5,8	-
wylot nr 21	<0,2	14 - 353	-	-	0,0016 - 8,26		wylot nr 46j	0,3 - 1,5	68 - 432	-	-	5 - 6,4	-
wylot nr 22	-	5,5	-	-	-	-	wylot nr 46x	<0,2 - 3,1	13 - 34000	-	-	0,0957 - 7,4	-
wylot nr 23	-	11 - 68	-	-	0,0024 - 0,5935	-	wylot nr 46y	<0,2 - 0,8	11 - 201	-	-	0,0567 - 5,2	-
wylot nr 24	-	5 - 135	-	-	0,0026 - 2,65	-	wylot nr 46z	<0,2 - 1	5 - 360	-	-	0,0125 - 6,2	-
wylot nr 25	-	10 - 34	-	-	4,2	-	wylot nr 47	<0,2 - 0,6	4 - 306	-	-	3 - 6,2	-
wylot nr 27	-	17 - 126	-	-	4,8	-	wylot nr 48	-	18	-	-	-	-
wylot nr 28	-	63 - 185	-	-	4,4	-	wylot nr A	<0,2 - 0,5	6 - 41	-	-	0,029 - 188	-
wylot nr 29	-	18 - 172	-	-	4,3	-	wylot nr B	<0,2 - 0,96	8 - 39	-	-	0,0194 - 3,4	-
wylot nr 30	-	6 - 79	-	-	0,0016 - 1,2	-	wylot nr C	2,4 - 2,9	7 - 175	-	-	1,4 - 6,2	-
wylot nr 31	-	9 - 32	-	-	0,0018 - 0,0116	-	wylot nr D	<0,2 - 0,4	6 - 198	-	-	7,4	-
wylot nr 32	-	8 - 199	-	-	0,0082 - 1,59	-	wylot nr E	<0,2 - 0,6	<2 - 293	-	-	7	-
wylot nr 33	-	12 - 46	-	-	0,0982	-	wylot nr F	<0,2 - 0,5	6,6 - 309	-	-	6,8	-

STORMWATER POLLUTION REDUCTION MEASURES

COLLECTING SAMPLES FOR ANALYSIS

Stormwater samples (collected from the third and fourth sampling campaign) from selected terminals were taken and prepared for the analysis in laboratory of Gdansk University of Technology. Samples were analysed and determined pH, electrical conductivity, redox potential, TP, P-PO43-, TN, N-NH4+, N-NO3-, N-NO2-, COD, BOD5, SO42-, S-, Cl-. Moreover, two experiments with potential autosampler fillings (activated carbon and polonite) have been conducted.

SEPARATOR AND SETTLING TANK

- The receiver of the stormwater or thaw water are sea basins. The water from port area is collected by the stormwater system into settling tank cooperated with separator.
- The main pre-treatment devices in port area are separators of petroleum substances with sandblasting and settling tanks. It is set up before the outlets and protects water basins from pollution.
- The maximum flow capacity of stormwater devices is calculated by using rainfall intensity (every 2 years) and duration (adopted 15 minutes).
- Technical company cleans pre-treatment devices with special machines, 2 times per year (checks quantity of sludge, code of sludge, technical condition).

EXISTING STORMWATER MANAGEMENT PRACTICES IN PORT OF KLAIPEDA, LITHUANIA

GENERAL INFORMATION PORT OF KLAIPEDA, LITHUANIA

Klaipeda State Seaport is the northernmost ice-free port on the eastern coast of the Baltic Sea. The port is the most important and biggest Lithuanian transport hub, connecting sea, land and railway routes from east to west.

Klaipeda is a multipurpose, universal, deep-water port, providing high quality services. 14 big stevedoring companies, ship repair and ship building yards operate within the port as well as all types of marine business and cargo handling services. The annual port handling capacity is up to 70 million tons.

The port can accommodate vessels 400m in length, up to 59m in width and with a maximum draught of 13.8m. The port operates 24 hours a day, 7 days a week, all year round.

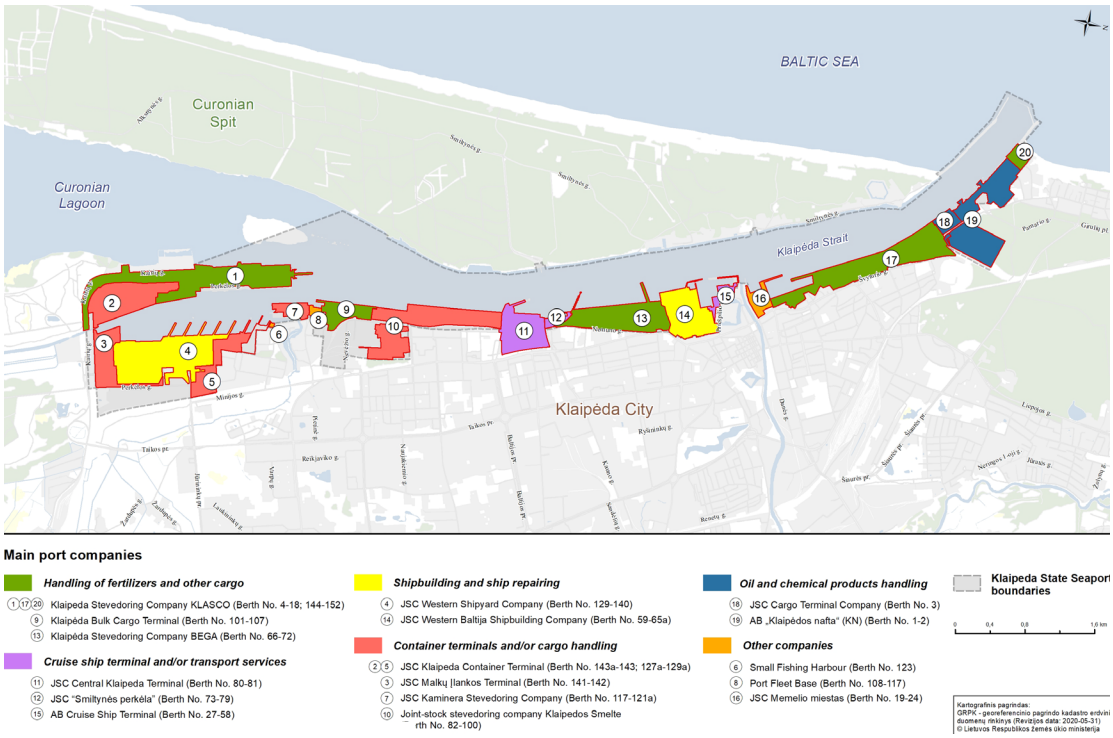
The short distances connect the port with the most important industrial regions of the eastern hinterland (Russia, Belarus, Ukraine etc.). Several shipping lines from Klaipeda to other main ports in Europe.

Characteristics of the Port of Klaipėda	
Port territory area	557,2 ha
Port waters area	884,9 ha
Number of quays	147
The length of port quays	24,7 km
Storage possibilities	
Area of covered warehousing facilities for general cargo	99 380 m^2
Area of warehousing facilities for bulk cargo	933 700 t
Area of warehousing facilities for refrigerated cargo	66 000 t
Area of open storage sites	1 045 879 m^2
Capacity of liquid cargo tanks	749 000 m^3

In the territory of the port there were about 20 enterprises and organizations that belonged to different authorities. In 1996 a law was passed relating to the Klaipėda State Seaport, which stated that the land and water territory, the quay-walls, hydro-technical equipment navigation routes, canals and other objects of infrastructure – belong to the state.

Year	**Port name**	**Total annual turnover, mln tones**	**General cargo, mln tones from which containers, thous TEU**	**Liquid bulk (Liquefied Natural Gas, oil, etc.), mln tones**	**Dry bulk (coal, cement, iron, grains, fertilisers, etc.), mln tones**
2016	**Klaipeda Port**	40,14	12,35 (443 TEU)	11,2	16,6
2017		43,17	12,4 (472 TEU)	11,5	19,2
2018		46,58	16,4 (750 TEU)	10,3	19,8

Cargo turnover in Klaipeda port in 2016-2018.



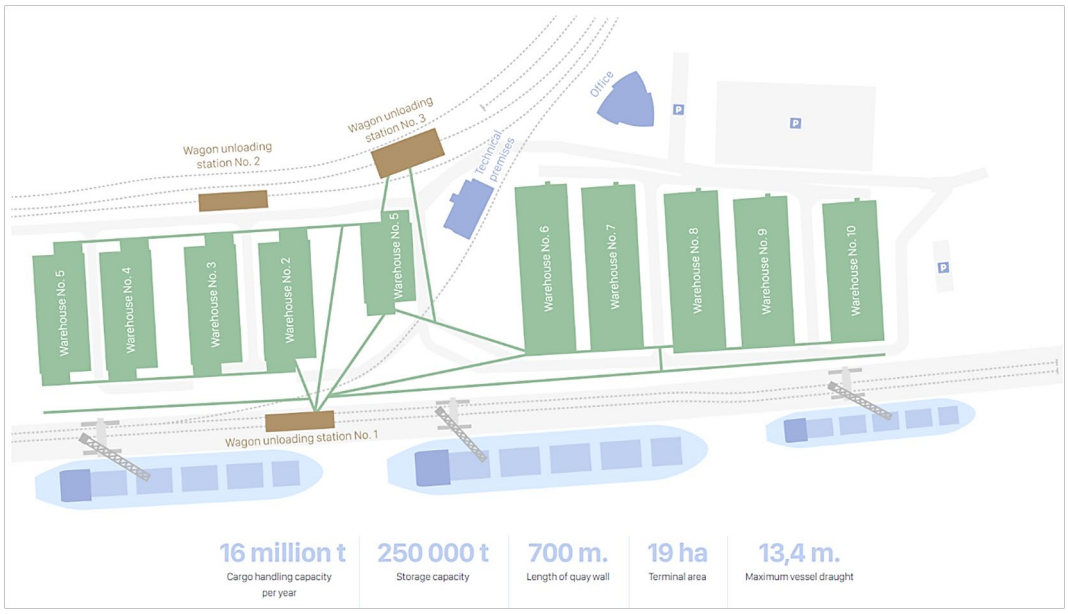
Klaipeda port plan.

BULK CARGO COMPANIES IN KLAIPEDA

The main content presented regarding Port of Klaipeda is based on the results of the assessment on the company Bulk cargo terminal (BCT) – one of three different bulk cargo companies operating in the port. Assessment was also conducted on Stevedoring company BEGA and Stevedoring company KLASCO

Bulk cargo terminal (BCT), founded in 1997 specialises in handling of bulk mineral fertilizers. BCT has become the largest stevedoring company in the port of Klaipėda. Over the years more than 105 million euros have been invested in new technologies, equipment, infrastructure and enhancing human resources.

Vessels, that are loaded at the terminal, distribute cargo to more than 100 countries reaching 5 continents of the world.



BCT infrastructure scheme and capacity.

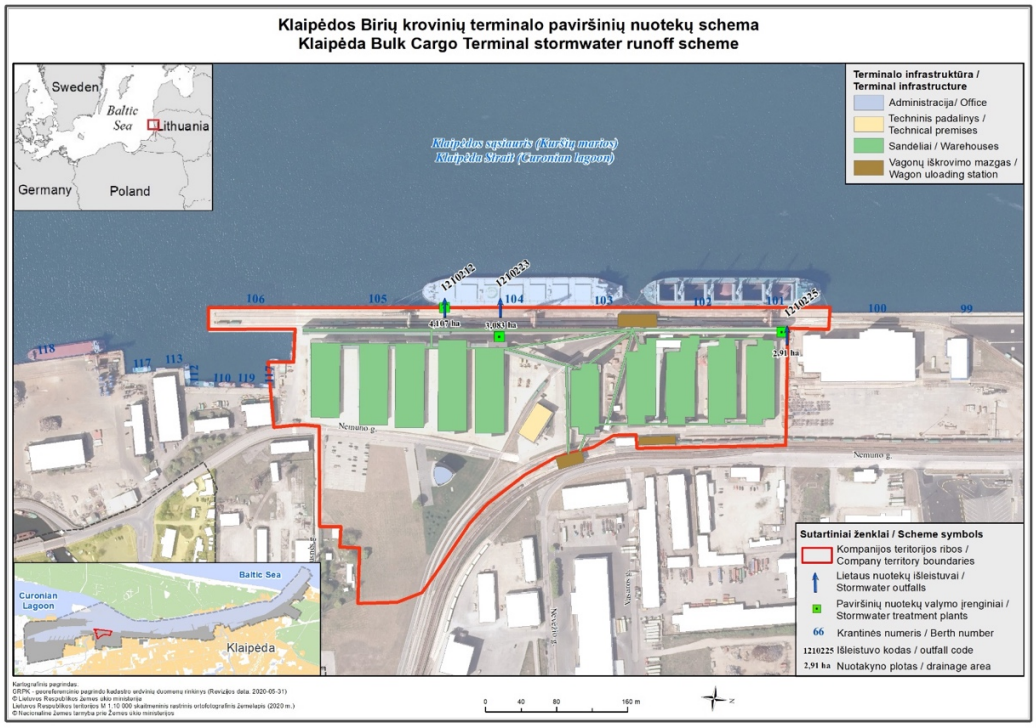
In the last decade the terminal fertilizer handling increased 7 times in terms of the number of tonnes handled. Potassium-based (K) - potassium chloride account for the largest amount of fertilizers handled (95%), ammonium sulphate (3%), others (2%).

	2015	2016	2017	2018	2019
Container handling	867 000	768 000	705 000	1 176 000	1 063 000
Loading to vessels	6 214 000	6 311 000	7 604 000	8 917 000	8 970 000
Total	7 081 000	7 099 000	8 309 000	10 093 000	10 033 000

BTC bulk fertilizer handling statistics 2015-2019.

STORMWATER DRAINAGE AREAS AND NETWORK

The total area of the company's territory is 18.96 ha, and the stormwater runoff, collected from 9.77 ha area is transferred by underground pipelines. Stormwater collected from the area of almost 6.3 ha is discharged into the Klaipėda Strait (Curonian Lagoon) through the two outfalls with installed wastewater treatment facilities – oil separators EuroPEK Roo Superkombi with integrated sand trap. Stormwater transported to the outfall No. 1210225 from 2,91 ha drainage area is treated in two oil separators - NPS35 with coalescence and absorption filters with capacity 70 l/s (2 x 35 l/s) and discharged into the Klaipeda city stormwater sewerage networks with subsequent discharge into Klaipėda Strait In order to determine the efficiency of the treatment, influent and effluent sampling wells were installed in all three treatment facilities.



BCT company scheme with marked company boundaries, stormwater outfalls, drainage areas size, treatment plants, quays and main infrastructure. *(Corresponding schemes from Stevedoring company BEGA and Stevedoring company KLASCO in Report 3.2 Stormwater drainage plan including the mapping of mostly affected area*)

Specialized ship loader no. and work area on quays	Outfall code	Drainage area, ha	Bulk fertilizer handling efficiency: average, max. t/hour	Volume of bulk fertilizers handled, mln. tons
Loader No. 2- quays No. 101-102	1210225	2,91	800-1200	3,15
Loader No. 3 - quays No.103-104	1210223	3,083	800-1500	4,05
Loader No. 1- quays No. 105-106	1210212	3,2103	800-1200	1,8

Short description of current activities in the drainage areas.

MONITORING AND ASSESSMENT

One of the major concerns regarding stormwater runoff is the direct contribution of nutrients, suspended solids and other contaminants into receiving water bodies. Integrated pollution prevention and control or IPPC permit (Directive 2008/1/EC) for large installations or Pollution Permit for small objects of economic activity (simplified LT version of IPPC permit) seeks to prevent and control, in a coordinated way, pollution of the air, water and soil resulting from the emissions of industrial objects. IPPC or Pollution Permit mean a written LT EPA authorisation to operate installation fulfilling the criteria set out in the Rules for the Issue, Updating and Revocation of Permits as approved by the LT Minister of the Environment. Such a permit stipulates environmental protection conditions for the operation of the installation in order not to exceed standards of environmental protection - establishes and control emission, discharge, dispersal limit values, standards for contaminants, sets procedure for monitoring and accounting for them, seeks to apply best available technique, etc. Thus, economic entities / operators, as well as Klaipėda port companies, which discharge stormwater into the environment and have an IPPC or Pollution Permit, must record data on stormwater management. Permissible qualitative parameters for stormwater discharges into the environment must be set by IPPC or Pollution Permit when stormwater collected from more than 1 ha potentially polluted drainage areas, except parking lots. This means that all port companies discharging stormwater effluents into the environment / water bodies must obtain IPPC or Pollution Permit.

The information provided in this report includes information and data collected from frequently updated BCT Pollution Permits, company's permit applications and other documents such as environmental impact assessment reports, Klaipėda port studies, literature review, etc.

Data on emissions to the air, stormwater quantitative and qualitative data are based on BCT company self-monitoring results. Individual operators shall submit annual air emissions data, as well as stormwater self-monitoring data to the LT Environmental Protection Agency (EPA). The EPA reviews, processes the received data and stores annual statistics of all companies in a database.

ASSESSMENT OF STORMWATER STATUS

According to the Pollution Permit monitoring plan agreed with the Environmental Protection Agency, the company must carry out qualitative research of stormwater discharged into the Klaipėda Strait (Curonian Lagoon). Sampling and testing shall be performed by a laboratory commissioned and licenced by the Environmental Protection Agency. For this purpose, grab samples are taken quarterly and the following average annual and maximum allowable concentrations of parameters are determined: suspended solids, BOD7, COD, total nitrogen, total phosphorus, petroleum products, sulphates and chlorides.

In accordance with the Stormwater Regulation approved by the Minister of Environment of the Republic of Lithuania, the actual amount of stormwater generated (m^3/year) is calculated according to the formula: Wf = 10 x Hf x ps x F x K

Hf: actual monthly/annual or other period precipitation, mm (according to the data of the Lithuanian Hydrometeorological Service); average annual rainfall - 735 mm/year; maximum precipitation rate - 73.9 mm/day.
ps: surface water discharge coefficient avg. ps = 0.83
F: discharge area of the territory, ha;
K: surface runoff coefficient depending on whether snow is removed from the area. If snow is removed K = 0.85, if not removed - K = 1.

Summary of 2016-2018 self-monitoring data is provided in table below. The annual average 30 mg/l permissible concentrations of total nitrogen (Ntot) were slightly exceeded in 2017 in the outlet No. 1210225, located near the quay No. 101, where large amounts of bulk fertilizers are loaded (3.15 million tons/year). Before reaching the outlet, collected stormwater is treated with an oil product separator with coalescence and absorption filters, afterwards it is discharged into the surface wastewater networks operated by Klaipėda city and further into the Klaipėda Strait water body. This outlet is characterised by the maximum Ntot values of 148 mg/l in 2017 (limit value 45 mg/l). Half lower concentration - 71.9 mg/l, still exceeding the permissible concentrations,

determined in the outlet No. 1210223, located in the zone, characterised by the largest amounts of loaded bulk fertilizers (4.05 mln. tons per year).

Through the outlet No. 1210225 the highest three-year average/mean amounts of organic and biogenic media – BOD7, SS, Ntot and Ptot, reaching 168.8, 295.8, 485.7 and 7.3 kilograms per year, respectively, are released. Slightly lower amounts of mentioned substances, with the exception of Ntot, are released through the outlet No. 1210212.

Although the grab sampling method does not provide reliable information on actual pollutant concentrations in stormwater effluents including the expected pollution loads, it does provide an opportunity to make a preliminary assessment of the current situation as a guide. Summarised three-year self-monitoring data show that the BCT company releases from 0.6 (2018) to 0.85 tons (2017) of suspended matter per year with stormwater. Slightly higher amounts of total nitrogen: from 0.7 (2018) to almost 1.57 tons in 2017, and organic matter-BOD7, from 0.4 (2018) to 0.5 (2017) tons. Small amounts of total phosphorus released, amounting to about 14.5 kilograms per year. The highest loads of all analysed pollutants were determined during the period of the highest surface runoff in 2017, caused by the rainiest years in Lithuania, when the average annual precipitation was 875 mm.

Year	Outlet code	Drainage area, ha	Stormwater volume, thous m³/a	BOD_7			SS			Petroleum products			Total nitrogen			Total phosphorus			Chlorides, Cl			Sulfates, SO4		
				BOD Average annual concentration	Maximum grab sample concentration	Pollution load, tons/a	SS Average annual concentration	Maximum grab sample concentration	Pollution load, tons/a	Oil Average annual concentration	Maximum grab sample concentration	Pollution load, tons/a	N tot Average annual concentration	Maximum grab sample concentration	Pollution load, tons/a	P tot Average annual concentration	Maximum grab sample concentration	Pollution load, tons/a	Cl Average annual concentration	Maximum grab sample concentration	Pollution load, tons/a	SO4 Average annual concentration	Maximum grab sample concentration	Pollution load, tons/a
2016	1210225	2,91	19,7	9,28	15	0,1829	17,6	**38**	0,3469	0,684	0,98	0,0135	14,560	19,00	0,287	0,373	0,77	0,0074	626	741	12,3378	88	126	1,7344
2017	1 LD		24,5	5,86	13	0,1438	13	17	0,3190	0,899	**1,9**	0,0221	39,580	**148,0**	0,9713	0,191	0,264	0,0047	577,8	814	14,1789	213,8	**543**	5,2465
2018			15,0	11,975	**18**	0,1798	14,75	21	0,2215	0,497	0,65	0,0075	13,250	14,00	0,1989	0,662	**1,81**	0,0099	747,25	**836**	11,2192	89,5	109	1,3438
Mean			**19,7**	**9,0**	**18**	**0,1688**	**15,1**		**0,2958**	**0,7**		**0,0144**	**22,5**		**0,4857**	**0,4**		**0,0073**	**650,4**		**12,5786**	**130,4**		**2,7749**
2016	1210223	3,083	14,6	7,9	15	0,1151	11	15	0,1602	0,482	0,82	0,007	26,380	**71,90**	0,3842	0,251	**0,631**	0,0037	624,6	774	9,0973	208,6	**481**	3,0383
2017	2 LD		18,1	7,16	**16**	0,1298	8,8	12	0,1596	0,63	**1,21**	0,0114	17,060	38,30	0,3094	0,1	0,146	0,0018	570	777	10,3367	147	196	2,6658
2018			11,1	9,5	11	0,1054	10,45	**16**	0,1159	0,528	0,887	0,0059	16,250	21,00	0,1803	0,248	0,532	0,0028	620	**870**	6,8789	162,25	183	1,8002
Mean			**14,6**	**8,2**		**0,1168**	**10,1**		**0,1452**	**0,5**		**0,0081**	**19,9**		**0,2913**	**0,2**		**0,0028**	**604,9**		**8,7709**	**172,6**		**2,5014**
2016	1210212	3,2103	17,9	7,55	**12**	0,1352	8,375	12	0,1499	0,336	0,82	0,006	13,550	15,10	0,2426	0,161	0,25	0,0029	96,45	122	1,7266	86	89	1,54
2017	4 LD	+0,567	31,9	7,175	10	0,2286	11,75	18	0,3743	0,288	0,387	0,0092	9,000	13,00	0,2867	0,238	**0,69**	0,0076	264	475	8,4093	76,75	109	2,4447
2018			19,5	5,95	10	0,116	13,5	**21**	0,2631	1,08	**2,8**	0,021	16,750	**18,00**	0,3264	0,091	0,153	0,0018	569,5	**803**	11,0984	107,25	**144**	2,0901
Mean			**23,1**	**6,9**		**0,1599**	**11,21**		**0,2624**	**0,6**		**0,0121**	**13,1**		**0,2852**	**0,2**		**0,0041**	**310,0**		**7,0781**	**90,0**		**2,0249**

BTC company three-year self-monitoring data.

Year	No of out-falls	Total drainage area, ha	Stormwater volume, thous. m^3/a	BOD_7 Pollution load, tons/a	SS Pollution load, tons/a	Oil Pollution load, tons/a	N_{tot} Pollution load, tons/a	P_{tot} Pollution load, tons/a	Chlorides, Cl Pollution load, tons/a	Sulfates, SO_4 Pollution load, tons/a
2016	3	9,2033	52,2	0,4332	0,6570	0,0265	0,9138	0,0140	23,1617	6,3127
2017	3	9,2033	74,5	0,5022	0,8529	0,0427	1,5674	0,0141	32,9249	10,3570
2018	3	9,2033	45,6	0,4012	0,6005	0,0344	0,7056	0,0145	29,1965	5,2341

Total BCT company annual stormwater volumes and pollution loads for the years 2016-2018 period.

STORMWATER POLLUTION REDUCTION MEASURES

The following examples of technical and organisational measures are currently applied in Port of Klaipeda to reduce the pollution in stormwater. If not noted, the examples are a summary of measures implemented in 3 different bulk cargo companies operating in Port of Klaipeda; Bulk cargo terminal, Stevedoring company BEGA and Stevedoring company KLASCO.

OIL SEPARATOR (ONLY RELATED TO THE BTC COMPANY)

Stormwater collected from the area of almost 6.3 ha is discharged into the Klaipėda Strait (Curonian Lagoon) through the two outfalls with installed stormwater treatment facilities - oil separators EuroPEK Roo Superkombi with integrated sand trap. Stormwater transported to the outfall No. 1210225 from 2,91 ha drainage area is treated in two oil separators - NPS35 with coalescence and absorption filters with capacity 70 l/s (2 x 35 l/s) and discharged into the Klaipeda city stormwater sewerage networks with subsequent discharge into Klaipėda Strait. In order to determine the efficiency of the treatment, influent and effluent sampling wells are installed in all three treatment facilities.

STORMWATER INFLOW VALVE

- In case of oil spills (diesel) from vehicles or large amounts of fertilizer, the treatment plants are equipped with a stormwater inflow valve which is possible to close in 10 minutes and

stop polluted stormwater runoff into the Curonian Lagoon. Stormwater collected from the company's territory is treated in surface wastewater treatment plants.

LOADING TECHNIQUE

- Loading of cargo by grab crane: it is allowed to unload the cargo by lowering the grab not higher than 1m from the loading surface or already loaded cargo
- the grab must be completely emptied at the unloading site;
- when loading cargo through the hopper, the cargo must not protrude above the horizontal plane (top) of the hopper;
- Loading of cargo by specialized vessel loaders must be carried out not higher than 1m from the surface of the cargo in the ship hold;
- In case of winds speed higher than 20 m/s, cargo loading to vessels must be stopped.

DUSTING PREVENTION

- During the unloading of railcars, curtains are installed at the ends of railcars unloading unit in order to reduce dust emissions into the environment;
- Cleaning of the exterior structures of railcars at the railcar unloading station;
- Cargo transfer units between conveyors (cargo moved from one pickup point to one drop point) in partly closed galleries are equipped with air filters, the operation of which is duplicated with the conveyor control, i.e. air filters operate when conveyors are running;
- Return conveyor belt wipers adjustment/replacement as required;
- Cleaning of dusty structures of specialized vessels loaders after the loading;
- Periodical sweeping of the area with a sweeping machine;
- Periodical maintenance of stormwater treatment plants and air filters;
- Watering of storage areas and cargo during loading operations.

New, stricter requirements for reducing dust emissions from handling bulk cargo will be implemented by fulfilling the Minister's of Environment order of 1st of November 2020 Minimum requirements for dust reduction during storage, handling and transport of loose solids.

Project WISA
WISA (Water Innovation System Amplifier) is a 3-year project that will contribute to a cleaner Baltic Sea by developing and testing new green technologies to reduce pollution by stormwater from ports and other large hard surfaces.

The Baltic Sea is one of the world's most polluted seas. More than 45 million tonnes of fertilizer pass through the ports of the Baltic Sea annually, and the handling contributes to the release of fertilizers and nutrients into the stormwater. This leads to eutrophication with extensive algal blooms and dead seabed.