

## KLAIPĖDA REGION MUNICIPALITY MONITORING PROGRAMS ENVIRONMENTAL – METHODOLOGICAL APPROACHES

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**Abstract.** Klaipėda district environmental monitoring program is complex; consisting of air, open water pool, groundwater, soil, noise, and wildlife monitoring. This is one of the first environmental monitoring programs, which for the first time to include the wildlife monitoring. Each part of the monitoring program provided a short overview of monitoring the performance goal, the main tasks of monitoring, and the need for justification, the monitoring site selection methodology and other aspects.

**Keywords:** air, water, soil, noise, and biodiversity monitoring.

### 1. Introduction

The purpose of monitoring is to manage the environmental quality within the territory of municipality to obtain more detailed information about the state of natural environment within the local municipal territories after the observations than those obtained during the state environmental monitoring, which will make it possible to assess and predict environmental changes and possible consequences, to develop appropriate recommendations, to plan programs for mitigation of negative impact and plans as well as to implement the measures intended, to provide information to professionals and the public. Current existing laws in the Republic of Lithuania shall determine the tasks for the following monitoring:

1. Regular and systematic monitoring of the state of natural environment and its elements:
  - a) To determine anthropogenic impact of cities, villages, settlements and agricultural production on the water bodies of the area;
  - b) To determine the impact of regional industry, energy companies and transport on the state of environmental air, noise level, quality of surface-water, groundwater and underwater (infiltration) in the municipality of Klaipėda district;
  - c) To determine the extent of anthropogenic impact on the regional ecosystem (pollution of air and surface water caused by industrial enterprises).
2. To organize, assess and predict spontaneous changes resulting from anthropogenic effects, alternation trends of natural environment and possible consequences on-

going in natural environment within the municipality of Klaipėda district.

3. To collect, analyze and submit information to public authorities and the public about the state of natural environment necessary to ensure sustainable development, territory planning, decision making concerning social development, education and other needs.
4. To analyze and assess the effectiveness of ongoing environmental measures.

*Justification of the necessity for the monitoring program.* The law for monitoring of the environment of the Republic of Lithuania No X–595 of 4 May 2006 (Official Gazette, 1997, No 112–2824, 2006, No 57–2025) set the monitoring framework, where one part is the monitoring of local environment – environmental monitoring is carried out on territories assigned to them at the municipal level. Performance procedure of monitoring is governed by “General municipal environmental monitoring regulations” approved by the Minister of the Environment of the Republic of Lithuania by No D1–380 on 3 July 2007 (Official Gazette, 2004, No 130–4680, 2007, No 76–3035). It provides the procedure for the performance by the municipalities of environmental monitoring, preparation and adjusting of monitoring programs, data and information collection, storage and delivery to municipal authorities, educational institutions, individuals and legal persons. In accordance with the requirements of these provisions, monitoring programs for the individual environmental components of the municipality of Klaipėda district have been prepared.

Environmental monitoring program of the municipality of Klaipėda district is prepared for the period of five years (2011–2015).

*General data.* Municipality of Klaipėda district is in the western part of Lithuania, in Klaipėda County, eastwards of Klaipėda city, at the Curonian Lagoon and the Baltic Sea. 11 wards belong to the municipality.

The area of Klaipėda district is 133.59 thousand hectares (2% of Lithuania's area), of which: 53.3% – agricultural areas, 23.8% – forests, 9.5% – water bodies, 13.4% – cities, towns and villages. The district is located in a convenient geographical position.

## 2. Monitoring of environmental air

There is no stationary air pollution monitoring stations in the municipality of Klaipėda district. The quality of environmental air is not monitored within Klaipėda district according to the monitoring program of environmental air. Systematic air quality tests are omitted, monitoring of environmental air is not carried out.

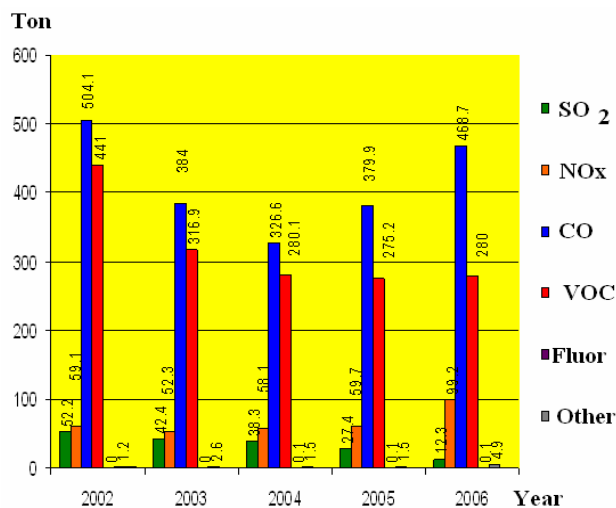
Main emission source in the atmosphere in Lithuania, as in many countries around the world, is mobile sources of pollution. Main part of pollution, i.e. 97%, has been emitted in the atmosphere by road vehicles and only 3% by other type of vehicles. The largest part in the structure of the pollutants made CO, NOx and VOCs. The data on what part of mobile sources of pollution emitted in the municipality of Klaipėda district is not available. It is likely that more pollution emitted by road vehicles falls on the regional lands bordering with Klaipėda city, ward centers and the parts of areas with a higher load of traffic, environment of trunk-roads and regional roads with more intensive traffic. According to the data by agencies of Klaipėda district which systematically carry out the monitoring of the quality of exhaust gas emitted by vehicles, the state of vehicles has improved in recent years – less number of cars with emissions exceeding standards has been determined. This is due to the juvenescent car parks, rising number of cars with improved emission catalysts, soot filters and those in accordance with the requirements of Euro 2.3.

904.6 tons of air pollutants from stationary sources of air pollution (the main energy and industry) fell into the air in Klaipėda district according to reports submitted by enterprises in 2008. Municipality of Klaipėda district is the fourth position among other municipalities of Klaipėda County according to the overall emissions, its part of exhaust emitted in the environment is relatively small within the county extent – it makes 8.85%.

Household has a significant impact on the quality of environmental air, as there is lots of pollution emitted from chimneys of private residential houses, which are more prevalent during the cold season, when the furnaces are fired intensely, and the meteorological conditions are not favorable for them to disperse. Another seasonal air pollution source is the burning of grass and debris in the spring, periodically repeated peat fires.

SO<sub>2</sub> and VOC emissions have decreased in Klaipėda district (Fig 1); other pollutants or groups of emissions

have increased (NOx) or changed marginally (CO). This was stipulated by a change in capacity of production and change of fuel in boilers and plants – changing of boiler fuel into gaseous fuel. Rather good situation in the region is shown by the emissions of solid and gaseous and liquid pollution from stationary sources falling to 1 km<sup>2</sup> area of regional territory. Amount of contaminants in this case is much lower than the average in the country.



**Fig 1.** Emissions of individual pollutants or groups into the air in the municipality of Klaipėda district

*The purpose of air monitoring* is to obtain and provide information based on systematic measurement or other methods intended to ensure optimal regulation of the quality of environmental air in terms of value changes in time and space (value of the concentrations in the air, flows into the ground surface, etc.).

Main objectives are: to collect and submit reliable information about the level of air pollution; to assess the impact of pollution carries from other countries; to determine the reasons of changes in the quality of environmental air; to assess the quality of environmental air in residence and public areas on the territory of municipality of Klaipėda district.

*Number of monitoring sites and their location.* It is intended to carry out the research of air pollution in 17 places of the municipality of Klaipėda district. The places located closest to the high-traffic streets, within the environment of public buildings (school, dispensary, cultural center, ward, etc.) and residential buildings nearby the pollution sources of potential risk (enterprises engaged in environmental emissions; boilers; trunk-roads; railways; agricultural companies, etc.) have been selected for measurement in the municipality of Klaipėda district. Environmental meteorological parameters are measured during the determination of air pollutants. During the first two years of the implementation of Monitoring program, to assess the influence of seasonality, measurements of SO<sub>2</sub>, NO<sub>2</sub>, VOC, PM<sub>10</sub> and CO pollutants are carried out four times a year. In the absence of exceedance of air standards, air quality is assessed by the approved program for simulation.

### 3. Noise monitoring

By the continuous development of industry, the growth of cities and the increase of the means of transport, the zones of discomfort become wider. Humans are exposed to the noise of cars, equipments, machines etc. (Lercher *et al.* 1996; Levine *et al.* 1998; Gražulevičienė and Deikus 1999; Malinauskienė and Gražulevičienė 2000; Toppila *et al.* 2000; Grubliauskas 2005; Butkus and Grubliauskas 2008). According to the data of the World Health Organization, 26% of all Europeans are exposed to noise levels higher than 65 dB(A). The total noise level increases approximately by 0.5–3 decibels per year. The noise level during the next 15 years might double. The noise of trucks and other heavy vehicles (i. e. busses) is approximately 10 times higher than of cars (Baltrėnas *et al.* 2008).

Noise aroused by rolling-stocks can be reduced by employing a large variety of means: by modernizing the rolling-stocks or acquiring more modern ones causing less noise, restoring or modernizing railroads, repairing railway cars and engines and modernizing diesel locomotives. Apart from that, technical means are employed: replacement of metal shoes of carriage brakes with composite ones, installation of lubricating systems of wheel rims of locomotives, polishing of rails, turning of car and diesel-powered locomotive wheels, welding of rails to eliminate joints, etc. The most cardinal way of dealing with the increasing dissatisfaction with noise and vibration caused by railway traffic is to forbid the construction of residential buildings in the areas where it is impossible to ensure a noiseless living environment (Bracciali and Cascini 1997; Frohner and Li 1998; Ono 2000; Baltrėnas *et al.* 2004; Grubliauskas *et al.* 2006; Gužas *et al.* 2006; Vėr and Beranek 2006; Baltrėnas *et al.* 2007; Baltrėnas *et al.* 2009).

Action plan for environmental noise prevention in Klaipėda district for the years 2008–2013 was confirmed by the decision No T11-469 on 25 September 2008 by the Municipal Council of Klaipėda District, which aims to provide complex environmental noise prevention measures in Klaipėda district, which would reduce the environmental noise and its effects on human health. Less than one hundred thousand population lives in Klaipėda district, thus strategic noise map for agglomerations is not available.

**Table 1.** Residents of Klaipėda district living in the sanitary railway protection zone according to the wards

No	Name of district	People number
1.	Kretingalė district	70
2.	Priekulė town district	277
3.	Dovilai district	150

About 500 residents live near the railway in Klaipėda district. Also, wind turbines are one of the industrial objects emitting noise. Currently, there are no individual wind turbines installed in Klaipėda district

(former wind turbines in the village Girkaliai are dismantled).

*The purpose of noise monitoring* is to receive systematic information about the change of noise level in the municipality of Klaipėda district, to assess the trend in their change, and make proposals for the reduction of their level.

Main objectives are: to assess the noise level in the locations sensitive for population: residential, children education establishments and health care areas, recreational areas; to determine the most problematic areas; to identify areas suitable for quiet public and quiet natural areas.

The results of noise monitoring will be used for the planning of noise mitigation measures.

*Techniques for noise level measurement.* Equivalent and maximum sound level of stationary and mobile sources of noise on the territory of residential homes, children education establishments is being explored and assessed. Equivalent and maximum noise in spring, summer and autumn seasons, during the morning peak, evening peak and at night is supposed to be measured at 24 measurement sites in the municipality of Klaipėda district. Periodicity of measurement is 7 days per season. Noise levels are measured and regulated in accordance with the procedure set forth in the following legal instruments.

### 4. Soil monitoring

Heavy metal pollution is one of the main ecological problems in the whole world (Gardea-Torresdey *et al.* 2005; Claus *et al.* 2007). Soil is contaminated by sour rains, boiler-house emissions and exhaust gas discharged from vehicles. Heavy metals are detected in farming lands and plants therein as well as various food chains, which finally cause serious ecological and human health problems (Malik 2004; Zheljaskov *et al.* 2006). The major part of chemical element emissions accumulates in soil and in deposits of water basin bottom. Soil is treated as a medium of both contaminant accumulation and contaminant transport. Upon getting into soil with dust, precipitation or in any other way, contaminants accumulate in it in the form of different combinations. From soil, they can enter plants and through them the food chains. They can also migrate to surface, ground and underground waters and spread at large distances, re-enter food chains and poison live organisms (Baltrėnas and Vaišis 2006). Heavy metals can migrate within soil, some of them accumulate in it and often disturb soil processes and sometimes can even cause soil degradation (Poszyler-Adamska and Czerniak, 2007; Jankaitė *et al.* 2008).

Soil may be the most important sink of metals and other pollutants. Trace metal contaminations are introduced into soil environment through a variety of human activities, such as waste disposal, mining and smelting (Wu *et al.* 2006).

Seven types of relief are met in Klaipėda district out of nine ones which may be distinguished on Lithuanian territory. According to the data from State Planning De-

partment Institute, the average score of agricultural landed property in the municipality of Klaipėda district is 39.5 (national average is 39.1 points). According to the data received from agency of Klaipėda district in 2010, soil monitoring within the territory of the municipality of Klaipėda district is carried out by UAB "Neo Group". Detailed research on soil contamination on the territory of the municipality of Klaipėda district has not been performed yet.

*Objective for soil monitoring* is to examine soil contamination and to provide information necessary for making economic and other important decisions for the district community.

*Objectives:* to collect soil samples for chemical analysis in selected sites regularly, to determine levels of heavy metals contained in samples collected, to provide information about the contamination of objects being monitored with heavy metals.

*Techniques for soil pollution measurement.* It is suggested to measure concentrations of heavy metals Cd, Cr, Cu, Ni, Pb and Zn in the soil located on the territory of the municipality of Klaipėda district. It is recommended to carry out examination on a single measurement site, i.e.: Ližiai, Endriejavas ward (former warehouse of pesticides and other chemicals). Soil tests are carried out in the intended location once during the period of implementation of Monitoring program. After having received and determined the data on a specific contamination, further examination of specific polluting substances may be carried out.

## 5. Water monitoring

Constantly expanding infrastructure of cities and roads causes anthropogenic impact on nature (Baltrėnas *et al.* 1996; Poszyler-Adamska and Czerniak 2007, Idzeliš *et al.* 2008). Different flora and fauna communities thriving in natural ecosystems undergo wide-scale human activity impact because of urban development. Increasing traffic flow induces the elevation of contaminants in soil nearby road, and heavy metals such as Cu, Pb, Ni, Cr, Zn amount a large majority among other chemicals (Baltrėnas and Vaišis 2006). Heavy metals can be accumulated by soil particles and living organisms, they may migrate in soil and destroy natural processes, and can enter surface and underground waters (Taraškevičius *et al.* 1999; Baltrėnas *et al.* 2003).

Intense traffic flows urge for the implementation of traffic safety measures, one of them being road maintenance salt (RMS) widely used in cold seasons, which consequently causes the negative impact on the components of road environment. RMS concentrations were evaluated in snow cover, soil (Norrstrom and Jacks 1998), underground waters (Thunqvist 2004), plants and trees (Viskari and Karenlampi 2000) in countries using salts for road maintenance. It was found that high concentrations of RMS (up to 3200 mg/l) accumulated in snow (Storpirštytė *et al.* 2004) together with snow melt water enter the soil and negatively affect roadside vegetation (Baltrėnas *et al.* 2006). The evaluation of the negative

impact of RMS on aquatic ecosystems according to diatom flora biodiversity demonstrated that this salt could influence the spreading of diatom flora which is specific to saline waters (Oškinis and Kasperovičius 2005).

Due to snow melting and rainfalls, traffic pollutants may be washed off and away from the soil surface and carried into the surrounding streams, rivers and lakes. The studies concerning the negative impact of traffic pollutants (and their mixtures) on aquatic biota are very scarce. However, it is considered that the adverse impact of traffic pollutants on aquatic ecosystems can differ depending on the level of contaminants, dynamics of exposure and on the characteristics of a water receiver. On the other hand, pollutants released from soil into aquatic ecosystems can affect freshwater chemistry (Thunqvist 2004) and induce threat to biota, especially in spring when many aquatic animals are most vulnerable. This negative impact can be short-term or intermittent; however, low concentrations of contaminants can induce a chronic stress in fish organism, which in turn can reduce their resistance to various environmental stressors. A better understanding of the impact of traffic emission pollutants requires integrated studies on pollutants fate in soil-water cycle and their impact on aquatic biota.

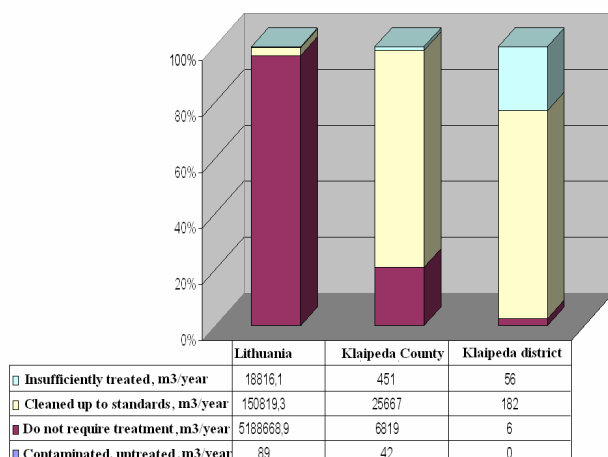
Water quality depends on the quantity of pollutants getting into the water and characteristics of the water bodies themselves. Municipal (household), industry and agriculture are among the major water polluters. Wastewater discharged by the residents and industry is assigned to the spot pollution, and pollution because of agriculture is called diffusible thus indicating the different nature of the distribution. One of the most topical problems of surface-water quality in Klaipėda district, as well as across the country, is their contamination with biogenic and organic substances.

Spot pollution, despite the fact that not only the change in water content has taken place (reduction in water consumption in industrial and municipal sector), the level of their cleaning has improved (wastewater treatment plants have been built or modernized) remains one of the most affecting the quality of surface-water.

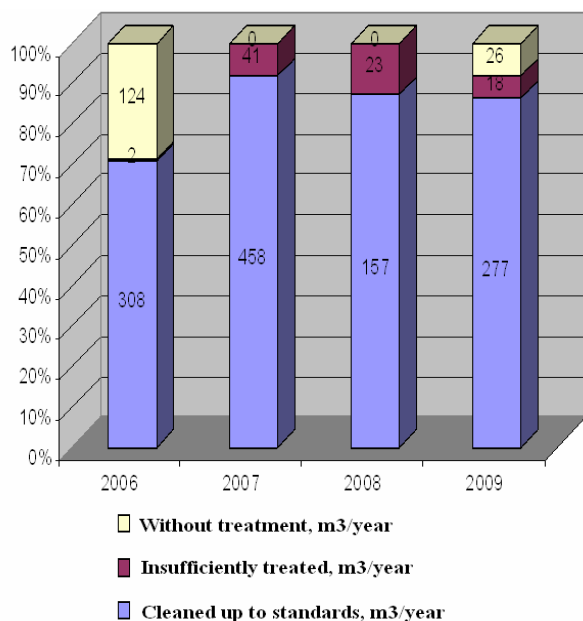
Major part of wastewater discharges in the municipality of Klaipėda district makes the wastewater cleaned up to set MPC standards – 74.6% of the total amount of wastewater discharged. The remaining amount of wastewater (23%) makes untreated wastewater. Compared with the previous year, their part has increased. According to the data of the year 2009, contaminated untreated wastewater is not discharged into open water bodies in the municipality of Klaipėda district (Fig 2).

The situation of the rainwater drainage of surface wastewater in Klaipėda district is improving each year. However, 26 thousand m<sup>3</sup> of surface wastewater without treatment has been released into the environment in 2009. One problem still remains in the district – the pollution of surface-water bodies by rainwater sewage. Rainwater sewage is cleaned by industrial enterprises only, which are fitted with the original rainwater treatment facilities, keeping oil products and sinking materials, and untreated

rainwater sewage of city streets and residential areas is discharged into open water bodies (Fig 3).



**Fig 2.** Domestic and industrial wastewater discharges into surface-waters in Klaipėda district in 2009



**Fig 3.** Discharge of surface wastewater of rainwater sewage in Klaipėda district in 2006–2009

The purpose of surface water monitoring is to carry out regular research of water quality (microbiological, parasitological and chemical pollution), to find out the possible sources of pollution in time and to warn people.

Surface water monitoring in Klaipėda district is conducted according to the concluded and approved State surface-water monitoring program. Monitoring of the Baltic Sea and the Curonian Lagoon is also carried out at the state monitoring level. The authority which implements state monitoring of surface-water is the Environmental Protection Agency. Data are available on [www.gamta.lt](http://www.gamta.lt).

According to the state river monitoring program, the water quality in the rivers within the municipality of Klaipėda district is being examined, which are in the areas of different impact (under the impact of natural background and urban diffuse pollution): Veiviržas, Minija, and Akmena-Danė. According to the state monitoring program of lakes, lakes in Klaipėda district are not examined. Intensive monitoring of maintenance of surface-water bodies in three spots of rivers in Klaipėda region was carried out in 2008. However, it is appropriate to carry out the research of surface-water bodies in the Agluona River at municipal monitoring program level to determine the effect of piggyery.

The purpose of monitoring of swimming holes is to determine and maintain the quality of swimming holes in order to preserve and improve the state of swimming hole, to capacitate safe conditions for human health.

Objectives: to assess the quality of swimming holes, to make water characteristics of swimming holes, to inform residents about the quality of swimming holes, to provide for measures for the improvement of the quality of swimming holes.

**Table 2.** Swimming holes where the monitoring on water quality will be carried out on the territory of the municipality of Klaipėda district

No	Name of surface water pool	Swimming hole	Name of district
1.	Gargždai pit	Gargždai	Gargždai
2.	Minija river	Gargždai	Gargždai
3.	Minija river	Priekulė	Gargždai
4.	Kapstatas lake	Endriejavas	Endriejavas
5.	Dovilai pit	Dovilai	Dovilai

Given the priorities of the Klaipėda district municipality, offers of public health professionals and after the assessment of popularity of water bodies, additionally, it is suggested to include two swimming holes into the monitoring of swimming holes: Kapstatas lake and Dovilai quarry (Table 2).

## 6. Monitoring of biodiversity

The following units represent priorities of conservation protection in the municipality of Klaipėda district: 11 state nature reserves.

The purpose of wildlife monitoring is the assessment and forecast of major trends diversity, profusion and productivity of change of natural wildlife species and conditioned anthropogenically.

Objects of monitoring – monitoring should be carried out throughout the territory of Klaipėda district, in natural and anthropogenic landscape in all its major biotopes. During the selection of monitoring sites and objects, a great attention must be given to available information, its efficient use. It is significant to focus observation on five types of objects (urbanized areas, agrarian (rural) landscape areas, forests, wetlands, water bodies).

Different parameters for individual groups of animals or species (mammals, birds, fish) living in different habitats and biotopes are being monitored: profusion of individual species, composition of species, age groups, sex structure, morphological parameters, the degree of conservation of habitat characteristics important for the observable species (Švažas *et al.* 2003; Naruševičius 2004; The Interpretation ...2007).

Specific sites for the monitoring of animal life in the municipality of Klaipėda district:

1. Urban areas (Gargždai and Priekulė towns).
2. Rural landscape (four areas with a distinctive rural landscape for choice).
3. Forests (5 forest arrays (Giruliai, Kliošiai, Padumbliai, Vėžaitinė, Aisėnai) with a characteristic (dominant) and rare (protected species) fauna.
4. Wetlands (Tyrai, Reiskas and Svencelė).
5. Water bodies (Kalotė Lake, Veiviržas, Minija, the coast of the Curonian Lagoon, Gargždai, Slengai, Poškai quarries).

Monitoring is carried out in accordance with the techniques for the monitoring of animal life applied by the State environmental monitoring program.

### 6.1. Monitoring of vegetation

*The purpose* is to monitor, assess major trends of changes of natural and anthropogenic vegetation, changes in diversity of species and community, to prepare the forecast on the change in vegetation.

*Monitoring of aquatic vegetation.* All waters in Klaipėda district belong to Venta watershed with a dense network of rivers and streams. Most of rivers in Klaipėda district are clean enough, only the pollution of Venta increases beneath Mažeikiai town. There are only four natural lakes and three ponds in the district. Given these characteristics, the monitoring of aquatic vegetation should be carried out in the Minija River (above and below the Priekulė), Kalotė Lake and Agluonėnai pond. Monitoring is carried out in accordance with the methodology approved by the National Environmental Monitoring Program, where structure and location of plant (macrophyte) communities is assessed under the method of transect (Monitoring Ecosystem... 2003).

Monitoring operations of rare endangered and invasive species are periodically repeated every three years.

### 7. Conclusions

1. During the first two years of the implementation of Monitoring program, to assess the influence of seasonality, measurements of SO<sub>2</sub>, NO<sub>2</sub>, VOC, PM<sub>10</sub> and CO pollutants are carried out four times a year. In the absence of exceedance of air standards, air quality is assessed by the approved program for simulation. Environmental meteorological parameters are measured during the determination of air pollutants.
2. Equivalent and maximum sound level of stationary and mobile sources of noise on the territory of residential homes, children education establishments is being ex-

plored and assessed. Equivalent and maximum noise in spring, summer and autumn seasons, during the morning peak, evening peak and at night is supposed to be measured at 24 measurement sites in the municipality of Klaipėda district. Periodicity of measurement is 7 days per season. Noise levels are measured and regulated in accordance with the procedure set forth in the following legal instruments.

3. It is suggested to measure concentrations of heavy metals Cd, Cr, Cu, Ni, Pb and Zn in the soil located on the territory of the municipality of Klaipėda district. It is recommended to carry out examination on a single measurement site, i.e.: Ližiai, Endriejavas ward (former warehouse of pesticides and other chemicals). Soil tests are carried out in the intended location once during the period of implementation of Monitoring program.
4. Given the priorities of the Klaipėda district municipality, offers of public health professionals and after the assessment of popularity of water bodies, additionally, it is suggested to include two swimming holes into the monitoring of swimming holes: Kapstatas lake and Dovilai quarry.
5. Specific sites for the monitoring of animal life in the municipality of Klaipėda district: urban areas, rural landscape (four areas with a distinctive rural landscape for choice), forests (5 forest arrays with a characteristic (dominant) and rare (protected species) fauna; wetlands; water bodies.

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