EQS LIMIT AND GUIDELINE VALUES FOR CONTAMINATED SITES

Report

2017

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Introduction

This report has been developed within the EU-financed project INSURE. INSURE is a four year Interreg Central Baltic project running from September 2015 until August 2019. The project is a cooperation between seven partners from Sweden, Finland and Latvia. This report has been developed by The Latvian Environment, Geology and Meteorology Centre with support from the County Administrative Board of Östergötland regarding the situation for guideline and limit values in Sweden.

The report gives examples of what guideline and limit values that are used in Latvia and Sweden. The report also discuss how the values are used and how they are in comparison with values from other countries. The report focus on values for soil, groundwater, surface water, sediment and biota.

In order to identify if a site is contaminated or not, and perform a risk assessment for it, it is essential to have clear and scientifically based guideline or limit values of environment quality standards (EQS). However, approaches how to set guideline or limit values differs in different countries and territories. There are differences, in between countries, in the numeric values for the same pollutants and also between legal status of guideline and limit values.

In Latvia limit values are firmly established in national legislation, and foreign limit or guideline values can be used only in the case if there are no national limit values available.

In Sweden it is more common to use guideline values instead of limit values for soil. If there are no Swedish guideline values consultants can use other countries guideline or limit values for risk assessment. Before using guideline values it is important to consider if the value is applicable for the specific site.

In the next chapters some of the guideline and limit values that are used in Sweden and Latvia are described into more detail, a short comparison is given on limit and guideline values in different countries and territories. One part of the comparison is dedicated to the methodology aspect and how other factors, such as soil texture and type of land use are used and taken into account or ignored in different countries and territories.

To help understand the real situation with contaminated sites in Latvia, two additional chapters are included in the report: 1) an overview of relevant pollutants in contaminated sites in Latvia, and 2) findings of field visit of two Latvian contaminated sites, designated as pilot territories of different remediation activities of INSURE project from another project partners.

This report also contains references where the reader can find more information about the background to the different values and other issues, discussed in this report.

EQS guideline values in Sweden

Soil

Generic guideline values

The Swedish Environmental Protection Agency (SEPA) developed a model to derive guideline values for contaminated land in 2009, SEPA report 5976 [19]. The model was used to calculate the Swedish generic guideline values. In 2016 the model was partly revised and new guideline values were set for some pesticides and organotin compounds, table 1 in Appendix 1. The Swedish generic guideline values for soil are based on normal conditions at contaminated sites in Sweden. The guideline values apply to dry soil.

The generic values are intended to be protective of health and the environment at the majority of the contaminated sites. However they cannot be applied at all sites. In cases where the generic guideline values are not relevant to the conditions at a contaminated site site-specific guideline values can be calculated, which take into account the actual site conditions. The calculation program can be found at the SEPA web site [32].

Generic guideline values are not legally binding values. The guideline values are one of the tools used in risk assessments. In simplified risk assessment measured contaminant concentrations on site are compared with generic or site-specific guideline values. Guideline values, in the context of remediation of contaminated sites, are the contaminant concentration in soil under which the risk of harmful effects on human health, the environment or natural resources is acceptable. However, contaminant concentrations which exceed guideline values do not necessarily give rise to negative effects.

The generic guideline values are intended to protect people living on or visiting the contaminated site. The assessment of health risks takes into account exposure caused by direct contact with the contaminated soil as well as indirect exposure which can occur by the transport of contaminants to air, groundwater and plants. The guideline values also take into account protection of the soil environment on the site. Groundwater and surface water are also protected against effects which occur as a result of the transport of contaminants.

The final guideline value is the lowest of the values derived to protect the health, soil environment, groundwater and surface water. In addition, a number of adjustments of the guideline values are made in order to avoid acute toxic effects and the occurrence of free-phase organic contaminants in soil. Finally, the guideline values are checked to ensure that they are not lower than the background concentrations which occur naturally or which are a result of large-scale diffuse pollution.

An important part of the derivation of guideline values is the expected land use at the site. Land use determines the likely activities on the site and therefore determines which groups of people will be exposed to contaminants and to what extent exposure will occur. Land use also affects the degree to which protection of the soil environment is required on the site. The Swedish generic guideline values have been derived for two different types of land use, sensitive land use (KM) and less sensitive land use (MKM). The land use controls the activities that can be assumed to occur on the contaminated site and therefore the groups of people that can be exposed and to what extent that can be assumed.

- Sensitive land use (KM) means that the soil quality does not limit the land use. All groups of people, including children, adults and elderly, can stay in the area during a lifetime. Most of the ecological systems in the soil are protected and so are the groundwater and surface water. Sensitive land use generally corresponds to residential housing and parkland.
- Less sensitive land use (MKM) is where soil quality limits the choice of land use to for example industries, offices or roads. The groups of people who are assumes to be exposed are people who are working on the site and also children and elderly who are temporarily visiting the area. The soil quality provides conditions for soil functions that are necessary for less sensitive land use, for example the ability for vegetation to grow and animals to temporarily stay on the site. Groundwater up to a distance of 200 meters and surface water are protected. Less sensitive land use generally corresponds to commercial and industrial land use.

The generic guideline values are calculated with some assumptions. They are based on the chemical form in which the substances are present in the soil and are expected to provide the greatest risk. They are also based on normal dense soils and are calculated for contamination in the soil above the groundwater table.

When the SEPA generic guideline values are used in the investigation of contaminated sites one should also consider:

- They do indicate a level of contamination under which the risk of harmful effects on human health, the environment or natural resources is normally accepted in the context of remediation. This does not necessarily mean that contaminant concentrations that exceed guideline values give rise to negative effects.
- They are recommendations and one of many tools in the risk assessment of contaminated sites. They are not legally binding values.
- They are calculated on national basis and for a great number of situations.
- They do not indicate a level up to which it is acceptable to pollute.
- They are not directly useful for other contaminated media such as sediment, building material etc.
- They do not take into account synergies between contaminants.

When the generic guideline values are used on a contaminated site, the conditions for distribution and exposure should not deviate significantly from the assumptions in the model.

Dutch soil Intervention values

In cases where there is no Swedish generic guideline value there is a possibility to calculate site specific values using the model from the generic guideline values, see the chapter above regarding generic guideline values. But many times the consultants or authorities use guideline values from other countries instead, for example the Dutch soil Intervention values [4]. In Sweden the Dutch soil values have been used mostly for pesticides.

The Intervention values for soil indicate when the functional properties of the soil for humans, plants and animals are seriously impaired or in danger of being so. A contamination of soil above the Intervention values is deemed to be severe. The soil Intervention Values apply to dry soil. The soil Intervention values where first published in 2000, some of the values have been adjusted since then. More information about the Dutch Intervention values are to be found at the Ministry of Infrastructure and Environment website [33].

Groundwater

The Geological Survey of Sweden has general guideline values as well as trend reversal starting point values on national level for groundwater [34]. The guideline values and the trend reversal starting point values are for example used in the work for classifying groundwater according to the water framework directive. Some pollutants are subjected to these general guidelines for example some metals and chlorinated hydrocarbons, table 5 in appendix 1.

The SEPA´s Criteria for Environmental Quality Assessments, first published in 1999, constitute a system of classification which facilitates the interpretation of environmental data. The system can be used to determine whether values are low or high in relation to either a national average or baseline readings. In most cases these assessment criteria are to provide a basis for the assessment of current environmental conditions. The Environmental Quality Criteria were included in the appendix of SEPA report 4918, Methods for inventories of contaminated sites. The report has also been translated in to English [10].

Since the Water Framework Directive was adopted these environmental quality criteria, mentioned above, have been updated and replaced. The Geological Survey of Sweden published a new report regarding groundwater quality criteria in 2013 [26]. The new environmental quality criteria for groundwater have been established for a wide range of substances. Substances which generally occur naturally in groundwater have a classification based on comparison with background values and possible environmental or health effects (1 – very low, 2 – low, 3 – medium, 4 – high, 5 – very high). For substances of probable anthropogenic origin an assessment has been made based on the magnitude of the impact (1 – no or insignificant impact, 2 – some impact, 3 – significant impact, 4 – large impact, 5 – very large impact), table 6 in Appendix 1.

Since there are few guideline values regarding groundwater The Dutch groundwater Target and Intervention values [4] have been used in Sweden to evaluate contamination in groundwater, table 7 in Appendix 1. Just as in soil the groundwater values have been used for pesticides and also chlorinated compounds. Groundwater target values are assuming there is a negligible risk for the ecosystem in a long term perspective. For metals there is a distinction between shallow and deep groundwater. The reason is that deep and shallow groundwater contains different background concentrations. More information about the Dutch Target and Intervention values are to be found at the Ministry of Infrastructure and Environment website [34].

In Sweden the petroleum companies formed an organization, SPIMFAB, which have worked with investigation and remediation of gas stations between the years 1997 to 2014. For that project they calculated guideline values for sites contaminated with gas and diesel products, table 8 in appendix 1. Those values can be used as reference when other sites are contaminated with hydrocarbons [21].

Surface water

The Swedish Agency for Sea and Water Management has regulations and limit values for classification and environmental quality standards for surface water [31]. The regulation is based on the Water Framework Directives with values for priority substances and national environmental quality standards. In comparison to several other European Countries Sweden also has limit values for sediments and biota to determine chemical classification of surface waters, table 2 in Appendix 1.

Drinking water

The National Food Agency in Sweden has regulations regarding drinking water [5]. These limit values can also be used to evaluate contamination of groundwater, table 9 in Appendix 1.

Sediment

There are no Swedish generic guideline values for contaminated sediments except for some substances that can be found in the regulations regarding surface waters [31], table 3 in Appendix 1. To be able to classify sediments other countries guidelines values are therefore often used in Sweden.

Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, table 4 in appendix 1, are sometimes used in Sweden for evaluation of contaminated sediments. The guidelines are divided into two values, the lower value, referred to as Interim sediment quality guidelines (ISQGs) or TEL (threshold effect level) represents the concentration below which adverse biological effects are expected to occur rarely. The upper value, referred to as the probably effect level (PEL) defines the level above which adverse effects are expected to occur frequently. More information about how and when to use the different guideline values are to be found at the Canadian Council of Ministers of the Environment [3] and [6].

Norwegian Environmental Quality Criteria are also used in Sweden for risk assessment of sediments. The Norwegian Environmental Agency has for example Environmental Quality Criteria for sediments from I-V where I stand for Background and V for Severely bad [35].

Biota

To classify biota there is some guideline values in the table 3 in appendix 1 in the regulation regarding surface water [31].

EU also has regulations (1881/2006) on setting maximum levels for certain contaminants in foodstuffs. Information could for example be found regarding maximum levels in fish of a number of contaminants [15].

Discussion of EQS guideline values in Sweden

Sweden has guideline values for contaminated soil but is missing generic guideline values for contaminated sediment. Although, the Swedish Agency for Sea and Water Management has regulations and some limit values for sediments to determine chemical classification of surface waters that can be used in the work with contaminated sediments. To have more specific Swedish guideline values for sediments could although support the work with risk assessments of contaminated sediments. Generally, for all medias, there are guideline or limit values missing for some substances or groups of substances. The work is although progressing and for example last year the Swedish Geotechnical Institute presented preliminary guideline values for PFAS (Perfluoroalkyl substances) for soil and groundwater. Since last year there is also a proposal for guideline value and trend reversal starting point value regarding PFAS in groundwater. These values will be official during 2018.

A general comment although, both if using Swedish or other countries guideline values, is the importance of applying the relevant guideline value for a specific site or condition. The Swedish generic guideline values for soil cannot be applied at all sites, in cases where generic guidelines are not relevant, site specific guideline values can be calculated. Site specific guideline values are sometimes today calculated but the knowledge about the process could be improved both in general terms and for example regarding how to consider soil environment in the process.

EQS limit values in Latvia

Environment quality standards (EQS) in Latvia are divided by type of environment and there are different legislative acts that define EQS target, precaution and limit values for each type of environment.

Soil and subsoil

For soil and subsoil, there is Cabinet of Ministers Regulation No 804 “Regulation of the Quality Normatives for Soil and Subsoil”, issued on 25th October 2005 [14], which contains values of EQS (target, precaution limit and critical limit values) for certain amount of pollutants, depending from granulometric content of soil (or soil texture).

Granulometrically, soil can be composed from the particles with different size (**Table 1**).

***Table 1**. Classification of soil particles (soil texture) in Latvia*

Size of particles, mm	Type of particles
<0.002	Clay
0.002...0.05	Silt
0.05...2.0	Sand

In reality, soil is mixture from differently sized particles, and soil type is identified from content of certainly sized particles from soil textural triangle (**Figure 1**).

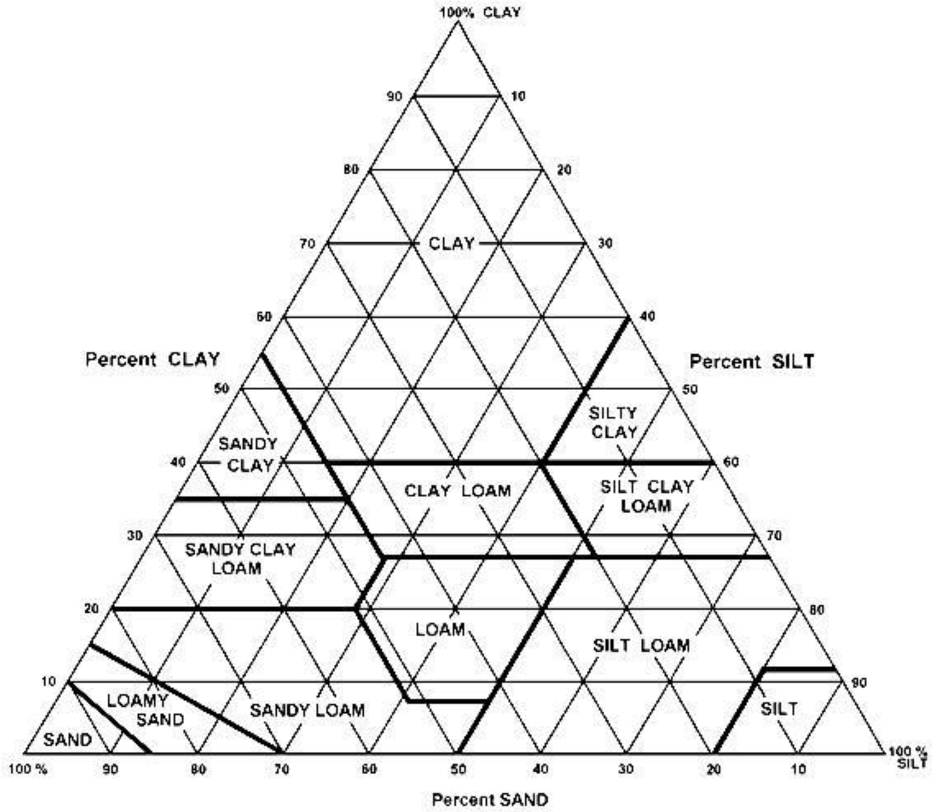

Figure 1. *Soil textural triangle*

Regulation No 804 defines three types of EQS for soil and subsoil:

- Target value EQS (A) shows the maximum concentration of pollutant of soil, exceeding of which leads to loss of sustainable quality of soil and subsoil;
- Precaution limit value EQS (B) shows the maximum pollution level, exceeding of which leads to potential harm to human health and environment. Besides, pollution must to decreased to this level as the result of remediation, if there are no other special requirements;
- Critical limit value EQS (C) shows the level of pollution, exceeding of which leads to serious disruption of functional properties of soil or direct harm to human health and environment.

Regulation also prohibits starting a new polluting activity on the soil, if the limit value (even of type B) is exceeded. If any of limit values has been exceeded, then, according to Law on Pollution, following measures should be carried out:

- Exploration and monitoring of contaminated site, if EQS of precaution limit value (B) has been exceeded or EQS of critical limit value (C) is exceeded for type II (**Table 3**) pollutants in the sites, which were designated as hazardous by regional environmental board of State Environment Service;

- Remediation of site, if the EQS of critical limit value (C) is exceeded.

***Table 2**. Soil and subsoil EQS limit values for type I pollutants (heavy metals, oil products, PAHs and PCBs) in Latvia (mg/kg)*

Parameter	**Sand**			**Clayous sand (sandy loam)**			**Sandy clay (loam)**			**Clay**		
	A*	**B****	**C*****	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Cu	4	30	150	7	40	150	12	50	150	19	60	150
Pb	13	75	300	13	100	500	16	200	500	23	200	500
Zn	16	250	700	24	250	700	46	350	700	70	350	700
Ni	3	50	200	8	75	200	16	75	200	28	100	200
As	2	10	40	2.5	10	40	3	15	40	5.5	20	40
Cd	0.08	3	8	0.09	3	8	0.18	4	10	0.2	4	10
Cr	4	150	350	11	150	350	22	170	350	40	170	350
Hg	0.25	2	10	0.54	2	10	0.8	3	10	0.8	3	10
Sum of oil products	1	500	5000	1	500	5000	1	500	5000	1	500	5000
Sum of PAHs (10 cmpnds)	1	12	40	1.2	15	40	1.2	18	40	1.5	20	40
Sum of PCBs	0.02	0.1	1	0.02	0.1	1	0.03	0.2	1	0.05	0.2	1

*A – target value EQS
**B – precaution value EQS
***C – critical value EQS

It is obvious that EQS values for soil and subsoil are more tolerant for soils with higher content of clay and less tolerant for soils with higher contents of sand, what can be explained by capability of clay to immobilize certain pollutants (mostly metals and oil products). However, granulometric composition of soil plays no role in the case of pollutants of type II (**Table 3**):

__Table 3.__ Soil and subsoil EQS limit values for type II pollutants in Latvia (mg/kg)

Pollutants	Target value EQS (A)	Critical value EQS (C)
Inorganic Compounds		
Free cyanides	1	20
Cyanide complex (pH<5)	5	650
Cyanide complex (pH≥5)	5	50
Aromatic Hydrocarbons		
Benzene	0.01	1
Ethylbenzene	0.03	50
Toluene	0.01	130
Sum of Xylenes	0.1	25
Sum of Phenols	0.05	40
Sum of Cresols	0.05	5
Chlorinated Organic Compounds		
Vynilchloride	0.01	0.1
Dichloromethane	0.4	10
1,1-Dichoroethane	0.02	15
1,2-Dichloroethane	0.02	4
1,1-Dichloroethene	0.1	0.3
1,2-Dichloroethene	0.2	1
Dichloropropane	0.002	2
Trichloromethane	0.07	15
1,1,1-Trichloroethane	0.07	15
1,1,2-Trichloroethane	0.4	10
Trichloroethene	0.1	60
Tetrachloromethane	0.4	1
Tetrachlorethene	0.002	4
Sum of Chlorobenzenes	0.03	30
Sum of Chlorophenyls	0.01	10
Pesticides		
Sum of DDT, DDE and DDD*	0.01	4
Sum of drins (Aldrin, Dieldrin, Endrin)	0.005	4
Sum of Hexachlorohyclohexane compounds	0.01	2
Atrazine	0.0002	6
Carbaryl	0.00003	5
Carbofuran	0.00002	2
2-methyl-4-chlorophenoxyacetic acid (MCPA)	0.00005	4
Other Pollutants		
Cyclohexane	0.1	45

*DDT – Dichlorodiphenyltrichloroethane, DDE – Dichlorodiphenyldichloroethylene, DDD – Dichlorodiphenyldichloroethane.

Although it is not clearly stated in the regulation No 804 but just like in Sweden, EQS limit values in Latvia:

- Should not be considered as the limit up to which it is allowed to pollute;
- Are not directly useful for assessment of another polluted media, such as sediment, building materials etc.;
- As it can be seen from the **Table 2** and **Table 3**, EQS limit values for different pollutants in Latvia are not dependant of each other, i.e. there is no consideration of the effect of their synergy.

Regulation No 804 states that depth of soil sample taking is 25 cm. If the layer of humus accumulation is thinner, the sample should be taken in the depth of the layer, but no shallower than 10 cm.

The average sample of the soil should be taken by mixing not less than 25 individual samples, taken evenly from the area to be tested. However, the area to be tested shouldn't be larger than 5 hectares.

To estimate the level of contamination of subsoil in the sites, where the source of pollution is migration of contaminated groundwater, the samples of subsoil must be taken with 50 cm interval in the entire depth of prevalence of the contaminated groundwater (including zone where level of groundwater fluctuates).

The regulation No 804 state clearly that EQS limit values refer to sample in form of dry solids only for heavy metals. For other pollutants this factor remains unclear. For example, so called "Dutch list", or the document "Annex A: Target values, soil remediation intervention values and indicative levels for serious contamination" [4], unlike the Latvian regulation, clearly states that all of its EQS limit values refer to content of pollutants in the dry solids.

There is no wide practice to use foreign EQS limit values in the Latvia. Only in cases, when there are pollutants, for which national EQS limit values are not available it is justified to use limit values from other countries.

Surface and groundwater

For surface and groundwater, there is Cabinet of Ministers Regulation No 118 “Regulation on the Quality of the Surface Water and Groundwater”, issued on 12th March 2002 [11]. This document mostly deals with EQS target and limit values for both priority substances and biogenic pollutants for surface water (dividing it into salmonid or cyprinids fish waters) and in groundwater, including limit values for water, deemed for abstraction as drinking water. EQS limit values for priority substances are harmonized with EU legislation – i.e., Directive 2013/39/EU “amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy” [27]. However, it contains EQS target and limit values for contaminated sites either, as well as EQS requirements for remediation of groundwater in the contaminated sites. Its summary is showed in **Table 4**.

Table 4. *EQS for groundwater in contaminated sites and its comparison with EQS for drinking water abstraction in Latvia*

Parameter	Unit or measurement	Groundwater in contaminated site		Ground-water limit value for abstraction as drinking water	Quality requirements for surface water deemed for abstraction as drinking water		Requirement for minimal reduction of pollution in result of remediation, %
		Target value	Limit value		Target value	Limit value	
COD	mg O_2/l	40	300		30		75
N_{tot}	mg/l	3	50		3		80
Synthetical surfactants	µg/l		200		500*		80
Phenol index	µg/l	0.5	50		10	100	60 – 70
Oil products (C_{10} – C_{40})	mg/l		1		0.5	1	60 – 70
Benzene	µg/l	0.2	5	1		2	60 – 70
Ethylbenzene	µg/l	0.5	60				60 – 70
Toluene	µg/l	0.5	50				60 – 70
Xylenes	µg/l	0.5	60				60 – 70
Cu	µg/l	10	75	2000	1000		60 – 70
Cd	µg/l	1	6	5	1	5	60 – 70
Pb	µg/l	10	75	10		50	60 – 70
Hg	µg/l	0.05	0.3	1	0.5	1	60 – 70
Cr	µg/l	10	30	50		50	60 – 70
Co	µg/l	10	100				60 – 70
Ni	µg/l	10	75	20		20	60 – 70
As	µg/l	10	60	10	50	100	60 – 70
Mo	µg/l	10	300				60 – 70

*Which reacts with methylene blue, µg/l Sodium Dodecylbenzenesulfonate.

Paradoxally there are some EQS for groundwater in contaminated sites that are more stringent than EQS for surface and groundwater deemed for abstraction as drinking water. This is a result of historical implementation of different European directives, regulating various aspects of water protection and use.

It should be noted as well, how Regulation No 118 in Point 26 defines application of EQS limit values for groundwater in the contaminated sites, and it is:

- If level of pollution has exceeded the mean arithmetic value between target and limit value, then boundaries of pollution plume must be determined, potential risk to human health and environment must be assessed and activities should be taken to avoid the spreading of pollution.
- If level of pollution has exceeded the limit value it should be evaluated if remediation of the site is necessary and if it is possible to carry it out without potential risk to human health and environment, taking into account geological, hydrogeological and hydrodynamic factors and anthropogenic pressure in site, as well as if the costs of planned remediation and control (monitoring) are reasonable enough. On the basis of assessment carried out deemed treatment level of groundwater for each site should be assigned individually and remediation should be performed according to the Law on Pollution [7].

Biota

For biota, there is the same Cabinet of Ministers Regulation No 118 [11], which was mentioned above regarding the EQS limit values for surface and ground water. Table 3 of Annex I of Regulation defines EQS limit values for certain pollutants (**Table 5**). If not stated otherwise, default EQS limit values are given for fish and they mean maximum allowed concentration of pollutant in the soft tissue of the water organisms without drying.

Table 5. *Latvian EQS limit values for certain pollutants in biota (µg/kg)*

Pollutant	CAS number	EQS limit value
Bromdiphenylethers	32534-81-9	0.0085
Fluoranthene	206-44-0	30*
Hg	7439-97-6	20
Hexachlorobenzene	118-74-1	10
Hexachlorobuthadiene	87-68-3	55
Benz-(a)-pyrene	50-32-8	5
Dicofol	115-32-2	33
Perfluorooctanesulfonic acid (PFOS) and its derivatives	1763-23-1	9.1
Dioxines:		0.0065** TEQ
7 Polichlorodibenzo-p-dioxines (PCDD)	1746-01-6, 40321-76-4, 39227-28-6, 57653-85-7, 35822-46-9, 3268-87-9, 19408-74-3	
10 Polichlordibenzofurans (PCDF)	51207-31-9, 57117-41-6, 57117-31-4, 70648-26-9, 57117-44-9, 72918-21-9, 60851-34-5, 67562-39-4, 55673-89-7, 39001-02-0	
12 Polichlorinated Biphenyls, similar to Dioxine	32598-13-3, 70362-50-4, 32598-14-4, 74472-37-0, 31508-00-6, 65510-44-3, 57465-28-8, 38380-08-4, 69782-90-7, 52663-72-6, 32774-16-6, 39635-31-9	
Hexabromocyclododecanes (HBCDD)	25637-99-4, 3194-55-6, 134237-50-6, 134237-51-7, 134237-52-8	167
Heptachlor and Heptachlor epoxides	76-44-8, 1024-57-3	0.00067

*EQS is set for crustacea and molluscs.
**EQS for fish, crustacea and molluscs, accordingly to EU Commission Regulation No 1259/2011 regarding content limits of Dioxines and PCBs in the food.

Despite of the availability of EQS limit values for biota, there is no wide practice in Latvia to use biota as indicator to identify the contaminated site. However, biota is sometimes used as indicator of water quality in the surface water bodies, as part of river basin management plans.

Comparison of EQS limit values for contaminated sites in Latvia with EQS limit and guideline values in ~~an~~other countries and territories

The EQS for soil in contaminated sites are applied differently in Latvia and in other countries. In Latvia, EQS limit values depend from soil texture (or granulometric content), while in another countries it mostly depends from land use classification. Most typical classification, which can be found regarding EQS limit or guideline values for contaminated sites, contains following types of land use;

- agricultural land,
- residential/parkland,
- commercial land,
- Industrial land.

This classification seems to be developed considering potential pathways of pollutants from contaminated sites to human body as well as access of the population to certain type of land and possible type of exposure to the pollutants.

Generally, people can be exposed to contaminants in soil through ingestion (eating or drinking), dermal exposure (skin contact) or inhalation (breathing). The route of human exposure to a soil contaminant will vary with the contaminant and with the conditions and activities at a particular site.

Many people, especially children, accidentally ingest small amounts of soil as part of their normal activities, such as performing yard work, gardening or playing. Young children usually ingest more soil than older children and adults because of their frequent hand-to-mouth behaviour. Children and adults may also ingest soil while indoors if soil is transported into homes or other buildings, such as on shoes, clothing or pets. Some contaminants, such as many pesticides, can pass through the skin and enter the body. People may also inhale contaminants bound to soil particles that become airborne (such as in windblown dust), or contaminants that vaporize from soil.

People can be exposed to contaminants in soil particles that stick to edible parts of garden produce or get taken up into garden plants from the soil. Animals raised for food may also take in contaminants from soil, and people may be exposed to these contaminants by eating animal products such as meat, eggs and milk. Drinking water may contain contaminants that were directly discharged into the water source or entered the surface water through runoff, or had leached from the soil into groundwater. In some situations, a contaminant may vaporize from the underlying groundwater and become part of the air that people breathe [20].

Thus, it is rather obvious that certain types of territories (i.e. agricultural and residential/parkland territories) are much more sensitive to potential contamination, unlike the other type of territories, where people are spending less time, where children do no play, or territory even has limited access – i.e., only authorized staff can enter and stay there.

Properties of each type of land use can be summarized in the following table (**Table 6**):

Table 6. *Typical land use classification regarding EQS for contaminated sites*

Type of land use	**Potential pathway of pollutants into human body**	**Level of accessibility**	**Potential exposure time**
Agricultural	Ingestion	Indirectly high	Long
Residential/parkland	Skin contact, ingestion	High	Moderate long
Commercial land	Skin contact, inhalation	Moderate	Moderate
Industrial land	Skin contact, inhalation	Low (restricted territories, only authorized personell allowed)	Short

Comparing approaches – the Latvian approach (using soil texture as factor for EQS limit values and not using type of land use) is not unique. However, soil texture, from the countries reviewed in this analysis, is much less popular factor than type of land use. Comparison is shown in the following tables:

Table 7*. Distribution of countries depending of use soil texture as factor to establish EQS limit or guideline values for contaminated sites or soil*

Taking into account soil texture	**Not taking into account soil texture**
• Latvia • Germany • Denmark	• Sweden • United Kingdom • Netherlands • Norway • Canada • Texas (USA) • Russia • Kazakhstan • Republic of South Africa • Nigeria

Table 8*. Distribution of countries depending of use type of land use as factor to establish EQS limit or guideline values for contaminated sites*

Taking into account type of land use	**Not taking into account type of land use**
• Sweden • Denmark • Germany • Nova Scotia (Canada) • Canada • Texas (USA) • Republic of South Africa • Nigeria	• Latvia • Netherlands • Russia • Kazakhstan

As stated above, it is easy to understand that agricultural land and residential/parkland are more sensitive to potential contamination than commercial or industrial land. Therefore, EQS limit or guideline values for contaminated sites are more stringent for agricultural land than for residential or parkland, and EQS for industrial land allows higher level of contamination than for commercial land. As higher is risk for pollution pathway and exposure, as stringent should be the corresponding EQS limit values.

Land use classification exists in Latvia, however, it has minor differences with the typical classification described above and at the moment it does not affect EQS limit values for contaminated sites in Latvia. Classification of land use in Latvia exists in Cabinet of Ministers Regulation No 305 “Regulation on the cadastral valuation”, issued 18th April 2006 [16], and in the Cabinet of Ministers Regulation No 240 “General regulation on the planning, use and construction in the territory”, issued 30th April 2013 [28]. The first regulation lists the type of land use or *zoning* as follows:

- Zone of the agricultural land;
- Zone of forest land;
- Zone of residential housing;
- Zone of industrial installations;
- Zone of commercial housing.

The second one gives a more detailed breakdown of the land use types or *functional zones*:

- Individual residential housing;
- Low-rise residential housing;
- Multi-storey residential housing;
- Mixed downtown housing;
- Public building territory;
- Industrial territory;
- Transportation infrastructure territory;
- Technical installations territory;
- Territory of nature and parkland;
- Forest territory;
- Agricultural territory;
- Surface water.

To harmonize various types of land use classification, the following transitional table was proposed in the terms of this project. However, the further decisions to adapt it in national legislation will depend from the competent institutions in the field of soil protection, classification and quality policy in Latvia (Ministry of Environment Protection and Regional Development etc.).

Table 9. *Proposed transition table of various classification of land use types*

Typical land use classification	**Latvian zoning types**	**Latvian types of functional zones**
Agricultural	Agricultural land	Agricultural territory
Residential/parkland	Residential housing	Individual residential housing
		Low-rise residential housing
		Multi-storey residential housing
	Forest land	Territory of nature and parkland
		Forest territory
		Surface water
Commercial land	Commercial housing	Mixed downtown housing
		Public building territory
		Transportation infrastructure territory
Industrial land	Industrial installations	Industrial territory
		Technical installations territory

Although this transitional table seems to be clear and logic enough, it is only a proposal and it may appear simpler than it is and some positions in the table can still be questioned if they are classified correctly.

For example, territory of nature and forest territory in the Latvian understanding are not exactly the same as residential/parkland in foreign classification, since territories of forest and nature in Latvia are very different and wide by their nature, differing a lot by accessibility and frequency of human presence. Some problems also exist with correct classification of transportation infrastructure territory – for example, highway or railway especially stretches with low or very low density of traffic, which easy can be accessed by people passing or children playing. It usual deal to transport oil products by railway in Latvia, and contamination of railway roads by leaking oil products is highly possible.

However, even with this transitional table (i.e. **Table 9**) it is impossible to compare Latvian and foreign EQS directly. Thus, the only way to compare them is to compare the intervals for certain pollutants, not taking into account soil texture (unless it is possible) and type of land use.

Also, taking into account there are present different types of EQS (for example, target values, precaution values, limit values and guideline values, which cannot be compared directly), it should be noted that this comparison at this stage is only to get a short insight how scattered and different each from other these EQS values really are. It should be also taken into account, that some foreign values can be only the proposed draft limit values or even maybe old and outdated standards. Proper and scientifically based comparison of EQS for the same conditions (soil texture, land use type, type of EQS) will request much deeper analysis, which is beyond scope of this analysis.

Table 10. *Comparison of EQS limit or guideline value intervals for heavy metals in the soil of the contaminated sites in different countries (mg/kg)*

Country (or region)	As	Cd	Cr	Cu	Pb	Hg	Zn	Ni
Latvia [14]	2...40	0.08...10	4...350	4...150	13...500	0.25...10	16...700	3...200
Denmark [12]	2...20	0.03....5	1.3...1000	13...500	10...400	0.04...3	10...1000	0.1...50
Netherlands [4]	29...55	0.8...12	100...380	36...190	85...530	0.3...10	140...720	35...210
Germany [9]	50	0.4...20	30...400	20...60	40...400	0.1...20	60...200	15...70
United Kingdom [9]	10	1	25	-	500	1	-	-
Norway [9]	20	1	100	-	50	1	-	-
Sweden*	10...25	0.8...12	80...150	80...200	50...400	0.25...2.5	250... 500	40...120
Russia [18]	2...10	0.5...2	6	55...132	30...130	2.1	55...220	85
Kazakhstan / Kirgizstan [29]	2	2	-	3.5	35	2.1	23	6.7
Japan [1]	15	-	-	125	-	-	-	-
Republic of South Africa [24]	48...150	32...260	-	2300... 19 000	230... 1900	1...6.5	19 000... 150 000	1200... 10 000
Nigeria [22]	200...625	100...380	20...240	0.3...10	35...600	85...530	1500	140...720
Texas, USA [36]	24...200	52...800	33 000... 120 000	1300... 94 000	500... 1600	3.6...6.2	9900... 25 000	840... 8800
Nova Scotia, Canada [30]	31	1.4...2090	220... 6700	1100... 20 000	140... 8200	6.6...690	5600... 47 000	330... 2200
Quebec, Canada [2]	5...15**	0.9...1.5**	45...85**	40...100**	30...50**	-	-	30...100**

*Table 1 of Appendix 1
**Background levels

Table 11. *Comparison of EQS limit or guideline values for organic pollutants in the soil of the contaminated sites in different countries and territories (mg/kg)*

Country (or region)	Sum of PAHs	Sum of PCBs	Sum of oil products	Sum of DDD, DDT and DDE	Drins (Aldrin, Endrin, Dieldrin)
Latvia [14]	1...40	0.002...1	1...5 000	0.01...4	0.005...4
Denmark [12]	1.5...15	-	25...100	1	-
Netherlands [4]	1...40	0.002...1	-	0.01...4	0.005...4
Sweden*	1...20	0.008...2	3...1 000	0.1...1	0.02...0.18
Republic of South Africa [24]	33...15 290	0.61...11	47 400...767 400	-	-
Nova Scotia, Canada [30]	34 100...60 400	22...33	-	220...1 600	16.8...218
Texas, USA [36]	1 869...19 290	1.1...7.7	-	29.4...274	9.155...202.2

*Table 1 of Appendix 1

Unfortunately, there are lot of organic pollutants and within limited resources of this project it is impossible to perform a deep and detailed study for all of them. Thus, only few pollutants were analysed.

It is obvious, that different countries use different EQS values, and it seems that there is not only slight differences (as, for example, with Latvia and Denmark, where EQS values although are not exactly the same, but at least are comparable), but rather different methodology or understanding of what EQS for contaminated sites is (for example, Republic of South Africa, Texas (USA), and Nova Scotia (Canada) have very different EQS limit or guideline values for contaminated sites, what most likely means that approach to estimate EQS in these countries or territories differs a lot from approach in another countries) as well.

Even the fact of Latvia, Denmark, Netherlands, Sweden, United Kingdom (UK) and Germany all are European Union member states, does not mean there is a harmonized EQS limit or guideline values, mostly due to EU Soil Directive has not been issued and adopted yet.

It is normal that there are inconsistencies for the lower values of the same pollutant in the different countries – since there can be target and/or background values presented for one country, while there can be precaution or the lower limit values for another country; such values can't be compared and there is nothing wrong if they differ.

It should also be taken into account that type of land use commonly plays a significant role in establishing EQS limit or guideline values. And in the countries or territories where EQS limit or guideline values are established depending on land use type (as, for example, in Sweden), it may not be connected directly with the thresholds to achieve in the result of remediation. And EQS limit or guideline values are rather viewed as thresholds, prohibiting to use contaminated territory for specific purpose. For example, contaminated site with certain level of pollutants can be not suitable to be used as residential or parkland territory, but it still can be safe enough to be used as industrial territory.

However, the largest values, considered to be direct "limit values" in most of countries, or the "worst scenario", should be rather comparable though. Thus, the limit values (i.e., largest EQS values) for Lead in Latvia, Sweden, Denmark, Netherlands, UK and Germany are quite close (400 – 530 mg/kg) – especially, considering the dependence on soil texture and land use type as well. That is, Latvian EQS limit value for lead can vary from 300 to 500 mg/kg depending is the soil texture dominated by the sand or the clay. But Lead limit values in Texas (USA), Republic of South Africa and Nova Scotia (Canada) are certainly out of range with corresponding limit values of 1600, 1900 and 8200 mg/kg. That is – it seems that site in the same conditions can be viewed as "contaminated" in one country, while being perfectly safe in the other!

Especially suspicious are EQS limit values, exceeding such levels as 100 000 mg/kg. For example, there is EQS limit value as high as 150 000 mg/kg for Zinc in Republic of South Africa, which can be recalculated as 150 g/kg, or 15% of Zn content in the soil. The same goes for limit value for oil products in the same country, with "worst scenario" limit value 767 400 mg/kg or up to almost 77% of oil product content in the soil sample, what appears to be not credible, since sample with such content of oil products most likely will be sandy oil, not oily sand, hardly possible to be called "soil". For comparison, in one of the top contaminated sites in Latvia (former military airfield "Rumbula" near Riga), where research of contaminated site was performed, and content of oil products in the soil was found to be up to 23 000 mg/kg [17].

Another interesting observation, it appears that European countries in general tend to have more stringent EQS limit or guideline values than countries for another parts of world (i.e. America, Africa etc.). Latvia also has one of the most stringent EQS limit values for contaminated sites.

One of possible explanation is that some of EQS, mentioned in this short analysis, is too stringent, while other ones are too tolerant. Another explanation can be that methodologies on how to evaluate or identify the contaminated site in different countries differ a lot. For example, some of EQS limit values definitions are strongly connected with toxicological properties of the pollutants, and it seems that EQS limit values sometimes are established according to the toxicity of the pollutant, taking into account that accidental ingestion of soil could happen.

As already mentioned before, it is not always clear, whether EQS limit or guideline value refers to content of pollutant in the dry solids or in the naturally wet sample. This can be one of possible explanations of obviously different approaches in establishing of EQS limit or guideline values. The brief overview of the requirements for the type of sample is shown in the following **Table 12**:

Table 12*. Requirements for soil sample type in different countries*

Countries (regions), clearly stating to use dry solid sample of the soil	Countries, at least partly referring to dry solid sample of the soil	Countries with no clear requirements regarding soil sample
• Netherlands • Sweden • Denmark • Nova Scotia, Canada	• Latvia • Germany • Norway • United Kingdom	• Republic of South Africa • Russia • Texas, USA

It is not the aim of this project to judge, which methodologies or EQS values are more correct and more scientifically based – rather it is to pay attention and raise the problem that large differences in the field of EQS limit and guidance values for the contaminated sites exist.

Short overview of relevant pollutants in Latvian contaminated sites

To identify most important Latvian EQS limit values, the list of relevant or "most popular" pollutants was made from the existing records of Latvian contaminated sites register (PPPV). However, it should be noted, that following analysis is limited by a few shortcomings:

- Most of data collected are old and can be outdated at the moment especially taking into account that updates of site status change due to completed investigation or remediation sometimes arrives to PPPV register with a considerable delay;
- Only small part of contaminated site records has information about type of pollutant present in the site (i.e., from total number of 3572 contaminated and potentially contaminated sites only 115 contains information about pollutants in soil and 242 – about pollutants in water [39]);
- It should be noted, that deeper study and inventory of all contaminated sites in Latvia can change the following list dramatically.

However, even this limited statistics can give an insight of pollutants, found in the Latvian contaminated sites.

***Table 13**. Known pollutants in the soil of the Latvian contaminated sites*

Pollutant	Number of contaminated sites
Oil products	94
Pb	22
Cu	17
Zn	15
Ni	8
Cr(VI)	8
Cd	6
Oil product waste	6
As	3
Hg	2
DDT	1
Metals	1
Spirits and Phenols	1
End of life vehicles	1

Table 14. *Known pollutants in the water* of the Latvian contaminated sites*

Pollutant	Number of contaminated sites
Oil products	178
Chemical Oxygen Demand	61
Total Nitrogen	27
Chlorides Cl^-	15
Ammonium NH_4^+	15
Biochemical Oxygen Demand	13
Pb	13
Zn	13
Anions	12
Oil product waste	11
Surfactants	11
Spirits and Phenols	10
Cu	5
Ammonia NH_3	5
Cr(VI)	4
Phenol index	4
Ni	4
Total Phosphorus	4
As	3
Sulphates SO_4^{2-}	3
Cd	2
DDT	2
Phosphates PO_4^{3-}	2
End of life vehicles	2
Agrochemical waste	1
Fluorides F^-	1
Hg	1
Creosote	1
Animal manure	1
Mn	1
Sodium alkyl sulphate	1

*****It is not specified is it surface water or groundwater

PPPV register contains also information about pollutants, which have been stored in the territory of the contaminated or potentially contaminated site. In this case there is more information available than in the case of pollutants in the soil or water, however it still covers only smallest part from the total number of sites registered. 1397 contaminated or potentially contaminated sites of total 3572 have been reported on having stored certain pollutants (**Table 15**).

***Table 15**. Number of contaminated sites where particular pollutants have been stored historically in Latvia*

Pollutant	Number of contaminated sites
Oil products	679
Agrochemical waste	258
Municipal waste	199
Animal manure	113
Oil product waste	69
Gasoline	32
Ammonia NH_3	27
Pesticides	12
Sewage sludge	11
Paint, lackuor, ink and glue waste	11
Spirits and Phenols	10
Animal and plant waste	8
Metal compounds	8
Acid waste	7
End of life vehicles	7
Oil and emulsion sludge	6
Waste electric and electronic equipment	6
Haloginated hydrocarbons and PCBs	5
Non-metallic compounds	5
Sulphates SO_4^{2-}	5
Sulphuric acid H_2SO_4	4
Cr(VI)	3
DDT	3
Mixed chemical waste	3
Ni	3
Phosphates PO_4^{3-}	3
Surfactants	3
Asphalt and bitumen waste from road construction	2
Cu	2
Chlorides Cl^-	2
Nitric acid HNO_3	2
Timber waste	2
Excavated contaminated soil	2
Alkalis and salts waste	2
Solvent waste	2
Zn	2
Amines	1
Anions	1
As	1
Phenol index	1
Hg	1
Lindane	1
Scrap metal	1
Sodium alkyl sulphate	1
Oil solvent	1
Ammonium NH_4^+	1
Nitrates NO_3^-	1
Pb	1
Turpentine	1
White spirit	1

Not all pollutants in these lists have EQS limit values established or even need such values, especially many pollutants listed in the “historically stored” list. For example, there never will be EQS limit values for such “pollutants” as end of life vehicles, waste electric and electronic equipment, animal manure and agrochemical waste, and sites, reportedly being contaminated with these and similar types of pollutants, most likely should and will be eventually inventoried to specify the exact type of pollutant. Also, presence of certain type of waste in the site can give a clue to identify specific pollutants in the soil or in the water or groundwater. However, even this information is not always available – as it can be guessed from the fact that most of sites, registered in Latvia, do not have any information on type of pollution present. Mostly only type of facility or economic activity is known for contaminated or potentially contaminated site.

However, if rely on this limited statistics on pollutants, present in contaminated and potentially contaminated sites in Latvia, it is possible to generalize that most priority pollutants in the soil of contaminated sites are oil products and heavy metals, and, occasionally, pesticides as well.

Also, this chapter raises another question - can a site be viewed as contaminated if it contains only pollutants that are not included in the national pollutant list for contaminated sites? I.e., is the Latvian methodology, used in practice to identify contaminated site, consistent and uncontroversial?

Experience of the pilot sites visit in the terms of applying EQS limit values

During field visit of two contaminated sites in Latvia, selected as pilot sites for deeper study and remediation by another Latvian project partners (Valmiera city municipality and Vidzeme Planning Region) – former black fuel (mazut) storage facility of Valmiera city heating company on the Dzelzceļa street and former storage facility of mineral fertilizers and pesticides “Krustmaļi”, following observations were made.

Former black fuel storage facility of Valmiera city heating company

Pilot site is located just north of individual residential houses (**Figure 5**). According to one assumption of this pilot area [37], the groundwater in this area flows roughly from north to south (**Figure 6**), i.e. in the direction of nearby residential housing (however, modelling done by LAMO Hydrogeological Model [40], gives a different direction of groundwater flow – from south-east to north-west (**Figure 7**).

Although the heavy fractions (i.e. black fuel) of oil products have a low mobility in the environment and trend to be bound on the surface of soil particles, certain degree of pollution spreading risk still remains, since black fuel also has a trend to form stable emulsions with water. Moreover, heavy oil products, including black fuel, contain higher levels of polyaromatic hydrocarbons (PAHs) than lighter fractions of oil products and PAHs have better solubility in water than linear hydrocarbons (alkanes) [13]. Despite of groundwater flow rate being relatively slow (i.e. measured in meters per year), the long age of polluting activity and pollution presence in site means that it had enough time to spread.

If the first assumption regarding direction of groundwater flow is true and remediation would be applied to this pilot site, it could be case, where application of different EQS limit values for contaminated site itself (black fuel former storage facility) and nearby residential area would be reasonable, due to their different sensitivity to pollution. However, it is and remains only “thought experiment”, because, as already stated, there is no distinction of EQS limit values for contaminated sites depending of land use type in Latvia.

Figure 2. View on the former former black fuel storage facility of Valmiera city heating company (photo from site visit in October, 2016)

Figure 3*. Remains of semi-liquid black fuel in the bottom of reservoir (photo from site visit in October, 2016)*

***Figure 4**. Residue of black fuel mixed with rain water near railroad branch for unloading of black fuel (May 2016)*

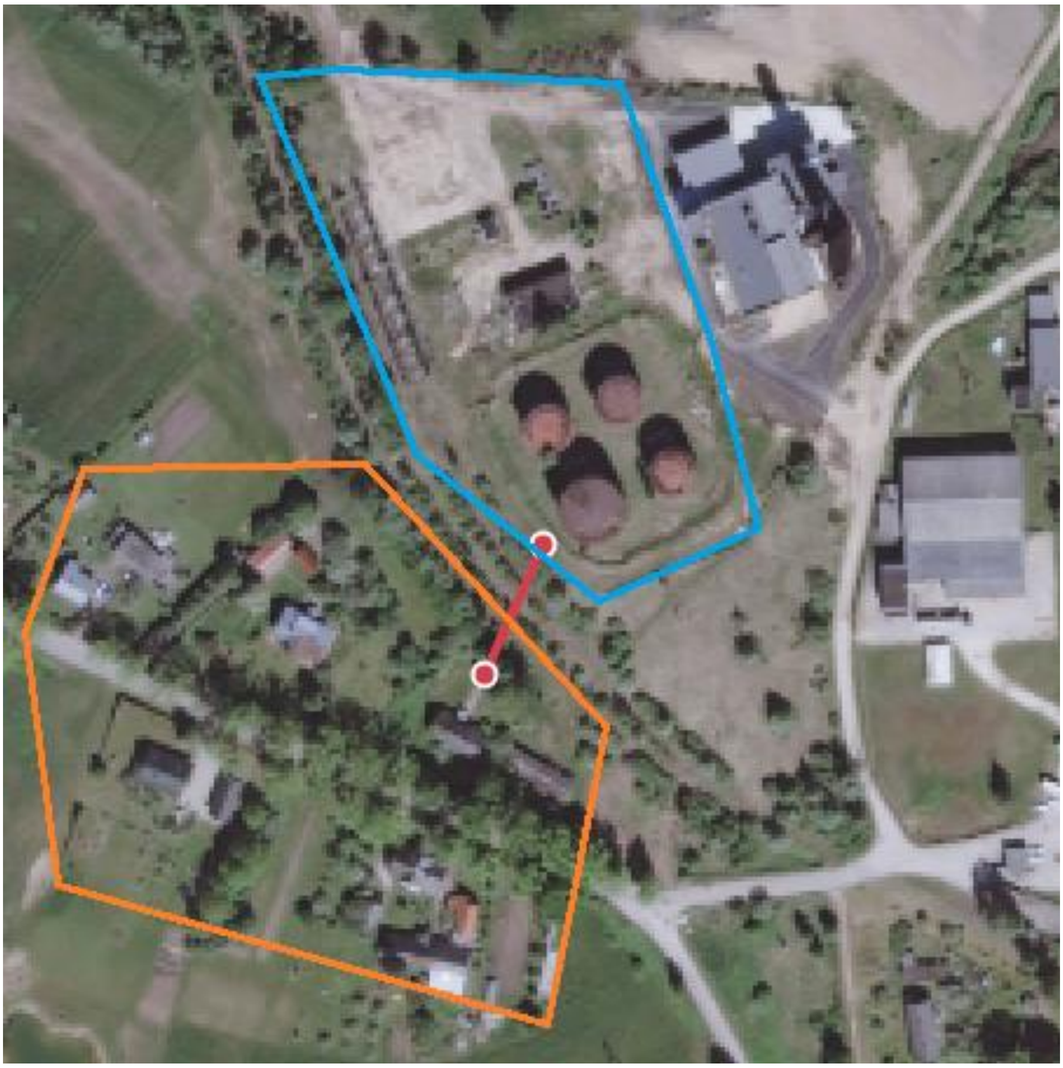

***Figure 5**. Rough scheme of pilot area of contaminated site – former black fuel storage facility of Valmiera city heating company. Inside blue line is contaminated site itself with buildings and fuel storage reservoirs. Territory inside orange line is a neighbouring residental housing, red line – rough distance measurement from the approximate border of contaminated site (i.e. fence of storage facility, since exact boundaries of pollution plume is unknown yet) to the well in the nearby housing. The distance between dots is 45 meters*. *Aerial photo from www.balticmaps.eu [41]*

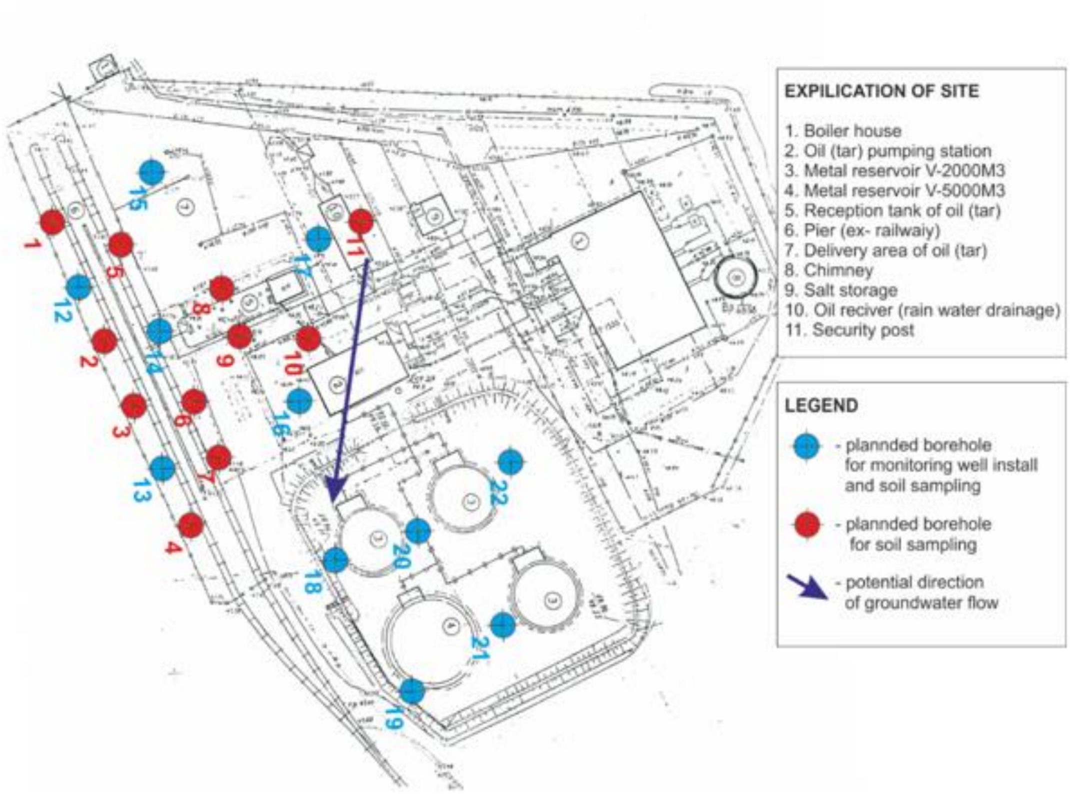

***Figure 6**. Planned boreholes for soil and groundwater sample taking in the Valmiera black oil fuel storage facility pilot area. Arrow shows potential direction of groundwater flow, suggested by consultants [37]*

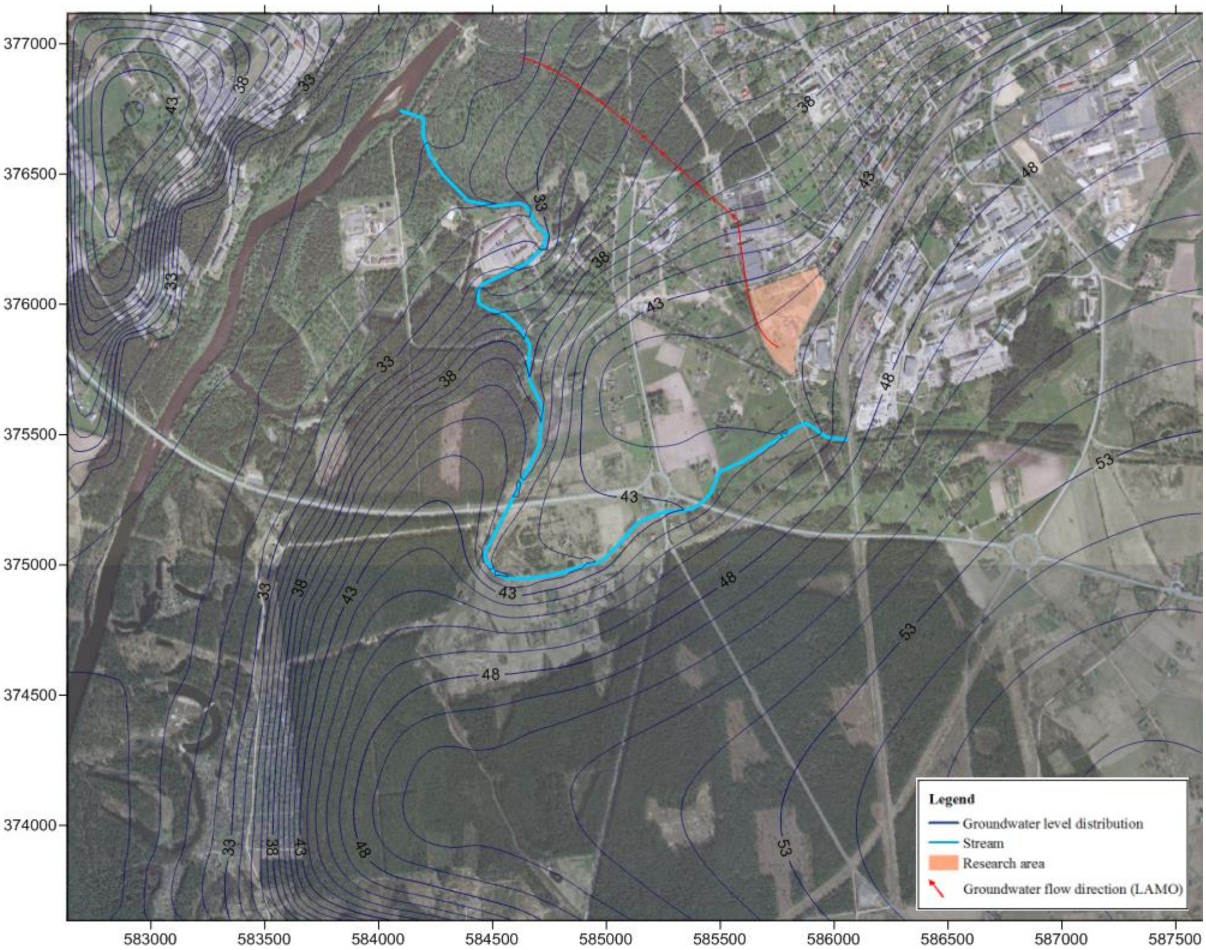

Figure 7*. Different estimation of direction of groundwater flow (red line) from the pilot site from contaminated site (orange area) to the nearby river [40]*

Former storage facility of mineral fertilizers and pesticides "Krustmaļi" (1960 – 1990)

Pilot site was once storage building (**Figure 8**), located on the roadside, surrounded from the other 3 sides with arable land (**Figure 9** and **Figure 10**). At the moment the building is demolished (**Figure 11**), and soil contamination with pesticides (DDT/DDE/DDD) was detected (in 2012 [23]). During the site visit in the October 2016, the crops in the field around the location of sites still were grown (**Figure 13**). In this case too, out of the boundaries where the building stood, and where crops are grown now, it would better to cultivate only technical crops (energetic corn or rapeseed, grown as biomass for production of biogas in the digesters or production of bio-diesel), or to ensure that soil is safe enough to cultivate crops for food. Especially taking into account that according to information available, pollution plume already protrudes out of boundaries where the building once stood (**Figure 12**). EQS limit values designated for agricultural land would be helpful in this case.

Figure 8. *"Krustmaļi" agrochemical storage building (2012)*

Figure 9. *Google Streetview image on the "Krustmaļi" site from the nearby main road (September 2011, [42]). Storage building is still standing and crops can be seen growing in the field*

***Figure 10**. Location of "Krustmaļi" site (roughly marked with blue). Red circle on the road is place from the Google Streetview image (**Figure 9**) was taken [42]. It can be seen that site is surrounded by the agricultural land*

***Figure 11**. Building demolished, floor and debris left. Sight very similar to that what was observed in the site visit in October 2016. Crop field and main road can be seen in the background*

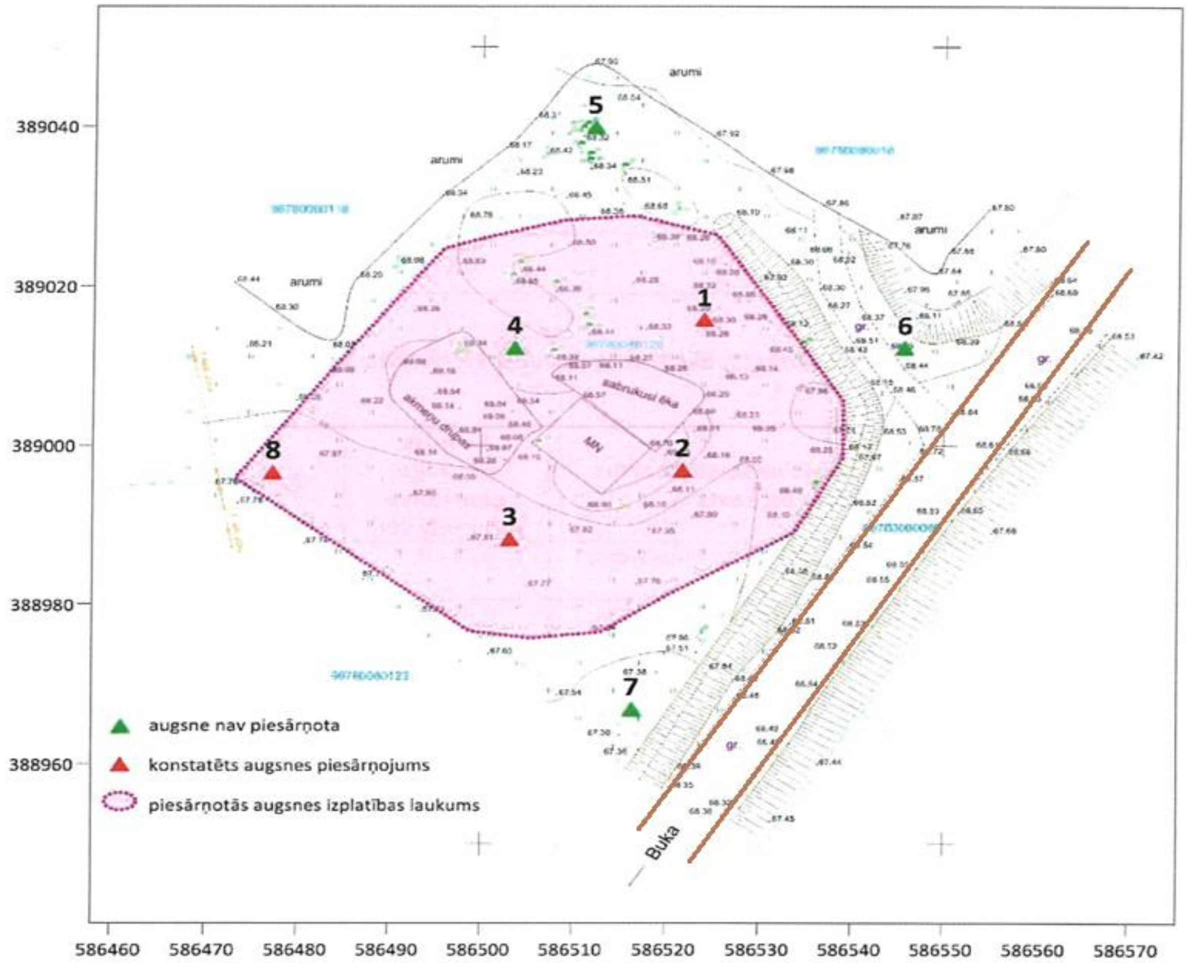

Figure 12*. Scheme of "Krustmaļi" site, with pollution areal marked (pink area – during site visit its boundaries were found to be marked with flags), samples with soil pollution detected (red triangles), samples with no pollution detected (green triangles), and rough marking of auxiliary road (brown lines). This scheme shows that area of pollution protrudes out of boundaries of former building and intrudes into the surrounding agricultural land [38]*

***Figure 13**. View on “Krustmaļi” site from the near crop field. Part of crops are located in the contaminated part of the land (photo from field visit in October 2016)*

Conclusions from pilot sites visit

Taken into account this information, available from partner pilot projects and site visit, the following conclusions can be made:

- In the terms of EQS limit value analysis, both pilot sites were chosen randomly – i.e. it was opportunity to visit these sites and get additional information regarding them because activities from other project partners were performed there. Despite of that, both pilot areas turned out to be located nearby the sensitive territories – i.e. residential housing in one case and agricultural land in the other, what means it could be more or less typical cases in the Latvia.
- In both cases spreading of pollution in the direction and into territory of sensitive neighbouring areas were either already proven (site “Krustmaļi”) or likely to a certain degree (former black fuel storage facility of Valmiera city heating company).
- Since both sites are designated as pilot territories for remediation activities, and there are no EQS limit values depending of land use type in Latvia, it means that as the successful result of remediation, the soil directly in the contaminated site (i.e. in the point of pollution source) and soil in the impacted sensitive area should be remediate up to the same level. It is not an optimal solution, since it would mean that either EQS limit values are too stringent for the industrial territories, where higher pollution levels could be allowed (and it would also mean higher costs of remediation), according to approach in many other countries, or that they are too tolerant for sensitive areas and in that case the threat for environment and/or human health would not be removed completely.

- According to Cabinet of Ministers Regulation No 483 “Procedure of identification and registration of contaminated and potentially contaminated sites”, issued on 20th November of 2001 [8], if the contaminated or potentially contaminated site is located near a sensitive territory, it gets more risk points in the process of its assessment. However, presence of sensitive territory nearby does not affect the EQS limit values for contaminated site in Latvia.

Discussion of EQS limit values in Latvia

- Only small part of contaminated and potentially contaminated sites in Latvia listed in the PPPV register has been identified with pollution present in soil, water or have been stored in the site historically.
- As far as it can be assessed from the information available, the most common pollutants in contaminated sites in Latvia are oil products, pesticides and heavy metals, other substances being present only occasionally.
- It seems that at least some contaminated (or potentially contaminated) sites in Latvia are including in the register of contaminated sites because of presence of pollutants, not included in the pollutant list of the national legislation regarding contaminated sites.
- Although type of land use is a factor, being taken into account in the process of identification and risk assessment for contaminated or potentially contaminated sites, it is not used for establishing EQS limit values in Latvia.
- Study of information, available for pilot sites of INSURE Latvian project partners, shows that there can be a different estimations of groundwater flow direction for the same site.
- During the field visit of two contaminated sites Latvia, designated as pilot sites for remediation activities by INSURE Latvian project partners, it was found that both of them are located close to residential or agricultural, with already proved or possible (to a certain degree) impact on them. Taking into account that in Latvia there are no EQS limit values depending on type of land use, these examples are good reason to reconsider this approach. As well as reconsider is it safe and cost-effective to achieve the same EQS limit values after remediation in the industrial, agricultural and residential land.
- There are cases when EQS limit values for surface or groundwater in the contaminated sites are more stringent than drinking water standards, meaning that water from contaminated site is perfectly safe for drinking, which is absurd situation.

Conclusions

- EQS limit values in Latvia are firmly established in a national legislation and is legally binding. EQS limit values in Latvia exist in up to 3 types – target, precaution and critical limit value and, for certain pollutants, can be dependant of granulometric composition of soil (or soil texture). There is no wide practice to use foreign EQS limit values for contaminated sites in Latvia, even in the cases, when no national EQS limit values exist for pollutant of the interest.

- EQS guideline values for soil are used in Sweden and can be very site-specific. An important part of the derivation of guideline values is the expected land use at the site. Land use determines the likely activities on the site and therefore determines which groups of people that will be exposed to contaminants and to what extent exposure will occur. Land use also affects the degree to which protection of the soil environment is required on the site. The Swedish generic guideline values have been derived for two different types of land use, sensitive land use (KM) and less sensitive land use (MKM). If generic guideline values are not available, it is possible to use guideline values from other countries. EQS guideline values for soil in Sweden are not legally binding. Sweden has limit values for classification and environmental quality standards for surface water where also some values for sediments are included but generic guideline values for contaminated sediments are missing. Sweden also has guideline values for the classification of groundwater and limit values for drinking water.

- Various and different approaches exist over the world on how to establish EQS limit and/or guideline values for contaminated sites. A general comment regarding guideline values is the importance of applying the relevant guideline value for a specific site or condition.

- Approaches consider or not consider different factors in establishing the EQS limit or guideline values. Such factors are: texture of soil, type of land use, limit or guideline value, precaution or critical value. Type of pollutant of interest, regarding its physical and chemical properties or analytical methods can be factors as well.

- Generally, range of EQS limit or guideline values for the same pollutant can be very wide in different countries, even in those countries which are EU member countries. However, in general terms, European countries tend to have more stringent EQS limit and/or guideline values for contaminated sites than countries from another parts of the world.

- Not all EQS limit or guideline values for soil are clearly stated to refer to content of pollutant in the dry solid sample. It is possible that this is another reason for EQS limit and guideline values to differ from country to country.

- Some foreign EQS limit/guideline values seems to be incredibly tolerant, especially when compared with level of contamination in actual contaminated sites in Latvia, which are classified as contaminated while having considerably lower levels of pollution than EQS limit values in some other countries.

- EQS limit values for surface water, at least for EU countries, are more harmonized due to Directive 2013/39/EU, issued to establish average annual and maximum allowed concentration EQS limit values for priority substances in surface water.

References

1. "Environment Quality Standards for Soil Pollution", Government of Japan, Ministry of Environment, 1994, https://www.env.go.jp/en/water/soil/sp.html
2. "Generic Criteria for Soils and Groundwaters", Soil Protection and Contaminated Sites Rehabilitation Policy, Quebec, 1998.
3. Canadian Council of Ministers of the Environment, 1999, http://ceqg-rcqe.ccme.ca/en/index.html
4. "Circular on Target Values and Intervention Values for Soil Remediation", "Dutch Target and Intervention values", 2000, http://www.esdat.net/Environmental%20Standards/Dutch/annexS_I2000Dutch%20Environmental%20Standards.pdf
5. National Food Agency in Sweden, regulation SLVFS 2001:30, https://www.livsmedelsverket.se/globalassets/om-oss/lagstiftning/dricksvatten---naturl-mineralv---kallv/slvfs-2001-30-kons-2015-3-webb.pdf
6. Canadian Council of Ministers of the Environment, 2001, http://ceqg-rcqe.ccme.ca/download/en/317
7. Law on Pollution, 2001, https://likumi.lv//ta/id/6075
8. Cabinet of Ministers Regulation No 483 "Procedure of identification and registration of contaminated and potentially contaminated sites" (issued on 20th November of 2001), http://likumi.lv//ta/id/55895
9. Recatala L., Mico C., Sanchez J., Boluda R. "Approaches for Characterising Contaminated Sites; an Analysis Considering the Role of Soil", Transactions on Ecology and Environment vol 46, WIT Press, 2001.
10. Swedish Environmental Protection Agency, Methods for inventories of contaminated sites, 2002, http://www.naturvardsverket.se/Documents/publikationer/620-5053-2.pdf?pid=2816
11. Cabinet of Ministers Regulation No 118 "Regulation on the Quality of the Surface Water and Groundwater" (issued on 12th March 2002), http://likumi.lv//ta/id/60829
12. "Guidelines for Remediation on Contaminated Sites", Environmental Guidelines No 7, Danish Environmental Protection Agency, 2002.
13. Kalniņa D. "Nafta un vides problēmas" ("Oil and environmental problems"), Riga Technical University, Riga, 2005.
14. Cabinet of Ministers Regulation No 804 "Regulation of the Quality Normatives for Soil and Subsoil" (issued on 25th October 2005), http://likumi.lv//ta/id/120072
15. European Union regulation EC 1881/2006, setting maximum levels for certain contaminants in foodstuffs, 2006, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R1881&from=SV
16. Cabinet of Ministers Regulation No 305 "Regulation on the Cadastral Valuation" (issued on 18th April 2006), http://likumi.lv//ta/id/134568
17. "Vēsturiski piesārņotu vietu sanācija" ("Remediation of Historical Contaminated Sites"), draft National program for European Regional Development Fund application, 2006, http://www.vidm.gov.lv/lat/finansu_instrumenti/kohez/files/text/finansu_instrumenti/koh_f/nac_prog_2007_2013//NP_piesarnojums.pdf

18. State Report "О состоянии окружающей среды в городе Москве в 2008 году" ("About State of Environment in the Moscow City in the 2008"), State Institution of Nature Protection "Mosecomonitoring", http://www.mosecom.ru/reports/
19. Swedish Environmental Protection Agency, Guideline values for contaminated land, report 5976, 2009, http://www.naturvardsverket.se/Documents/publikationer/978-91-620-5976-7.pdf?pid=3574
20. Shayler H., McBride M., Harrison E. "Sources and Impacts of Contaminants in the Soil", Cornell Waste Managemant Institue, Ithaca, 2009.
21. SPI, Remediation of contaminated gas stations and diesel plants, 2010, http://spbi.se/spimfab/files/2013/02/SPBI-rek_ebh-fororenade-bensinst-dieselanl_uppdaterad20120129.pdf
22. Wuana R.A., Okieimen F.E. "Heavy Metals in Contaminated Soils: a Review of Sources, Chemistry, Risks and Best Available Strategies for Remediation", ISRN Ecology, 2011.
23. "2007 – 2013. gada finanšu plānošanas perioda ierobežotas atlases 3.4.1.4. aktivitātes „Vēsturiski piesārņoto vietu sanācija" projektu saraksta papildināšanas iespēju izvērtēšana, veicot piesārņoto un potenciāli piesārņoto vietu reģistrā iekļauto vietu izvērtēšanu atbilstoši piesārņojumu pakāpei un nosakot to atbilstību vēsturiski piesārņotās vietas statusam" ("Evaluation of possibility to expand the list of project list for limited selection of activity No 3.4.1.4 "Remediation of Historically Contaminated Sites" for financial planning period for years 2007 – 2013, by evaluating sites, included in the PPPV register accordingly to their grade of contamination and identifying their accordance to the status of historically contaminated site"), Reserach ordered by Latvian Ministry of Environment Protection and Regional Development, 2012.
24. "Draft National Norms and Standards for the Remediation of Contaminated Land and Soil Quality", Department of Environmental Affairs, "Government Gazette", Republic of South Africa, Vol 561, Pretoria, 2012.
25. Rijkswaterstaat Environment, Soil Remediation Cirkular, 2013, http://rwsenvironment.eu/publish/pages/97218/soil_remediation_circular_2013_july_2013.pdf
26. Geological Survey of Sweden, Groundwater Quality Criteria, report SGU 2013:01, 2013. http://resource.sgu.se/produkter/sgurapp/s1301-rapport.pdf
27. Directive 2013/39/EU "Amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy" (issued 12th August 2013), http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:226:0001:0017:EN:PDF
28. Cabinet of Ministers Regulation No 240 "General Regulation on the Planning, Use and Construction in the Territory" (issued 30th April 2013), http://likumi.lv//ta/id/256866
29. Кулдунбаев Н.К., Фогт Р.Б., Арнолдуссен А., Сыдыкбаев Т.Н., Окланд Т.И., Эйлертсен О. "Содержание тяжелых металлов в почве национального парка «Беш-Таш»" ("Content of the Heavy Metals in the Soil of the National Park "Besh-Tash"), Вестник КАЗНМУ, 2013.
30. "Environment Quality Standards for Contaminated Sites", Rationale and Guidance Document, Nova Scotia Environment, 2014.
31. Swedish Agency for Sea and Water Management, regulation HVMFS 2015:4, https://www.havochvatten.se/download/18.39e6d68414ca353051f2d15d/1429085661024/HVMFS+2015-4-ev.pdf

32. Swedish Environmental Protection Agency, Calculation program, version 2.0.1, 2016, http://www.naturvardsverket.se/upload/stod-i-miljoarbetet/vagledning/fororenade-omraden/Version2-0-1-nv-berakningsprogram-rv-mark20160706.xlsm
33. Ministry of Infrastructure and Environment, website 2016-11-30, http://rwsenvironment.eu/subjects/soil/legislation-and/soil-remediation/
34. Geological Survey of Sweden, regulation SGU FS 2016:1, http://resource.sgu.se/dokument/om-sgu/foreskrifter/sgu-fs-2016-1.pdf
35. Norwegian Environmental Agency, Grenseverdier for klassifisering av vann, sediment og biota, Miljödirektoratet, M- 608, 2016, http://www.miljodirektoratet.no/Documents/publikasjoner/M608/M608.pdf
36. Texas Risk Reduction Program Protective Concentration Levels", Texas Commission on Environmental Quality, Tier 1 PCL and supporting tables, 2016, https://www.tceq.texas.gov/remediation/trrp/trrppcls.html
37. "Ar naftas produktiem potenciāli piesārņotas mazuta saimniecības teritorijas izpētes stratēģijas izstrāde, ietverot teritorijas topogrāfisku uzmērīšanu" ("Development of Investigation Strategy, Including Topographic Survey, for Territory of Black Fuel Storage Facility, Potentially Contaminated with Oil Products"), SIA "Vides Konsultāciju Birojs", 2016.
38. "Projekta INSURE pilotvietu izpētes stratēģija Vidzemes plānošanas reģiona teritorijā" ("INSURE project pilot sites investigation strategy in the territory of Vidzeme planning region"), Vidzeme planning region, 2016.
39. "Piesārņoto un potenciāli piesārņoto vietu informācijas sistēma" (Latvian Information System of Contaminated and Potentially Contaminated Sites), http://oas.vdc.lv:7779/lva/ppv_read_pub/
40. LAMO Hydrogeological Model, Riga Technical University.
41. www.balticmaps.eu
42. www.maps.google.lv

Appendix 1. Guideline and limit values

Table 1. Swedish Environmental Protection Agency generic guideline values for soil, 2009.

Parameter	Unit	Sensitive land use (KM)	Less sensitive land use (MKM)	Comment
Antimony	mg/kg dry weight (dw)	12	30	
Arsenic	mg/kg dw	10	25	
Barium	mg/kg dw	200	300	
Cadmium	mg/kg dw	0,8	12	Revised June 2016
Chromium (VI)	mg/kg dw	2	10	Note 2
Chromium total	mg/kg dw	80	150	If the percentage of chromium (VI) is greater than 1% of the total amount of chromium, chromium (VI) should also be assessed for risk.
Cobalt	mg/kg dw	15	35	
Copper	mg/kg dw	80	200	
Lead	mg/kg dw	50	400	
Mercury	mg/kg dw	0,25	2,5	
Molybdenum	mg/kg dw	40	100	
Nickel	mg/kg dw	40	120	
Vanadium	mg/kg dw	100	200	
Zinc	mg/kg dw	250	500	
Cyanide (total)	mg/kg dw	30	120	
Cyanide (free)	mg/kg dw	0,4	1,5	Note 2
Total phenol and cresols	mg/kg dw	1,5	5	Note 2
Sum of chlorophenols (monopenta)	mg/kg dw	0,5	3	Note 2
Sum of mono- and dichlorobenzenes	mg/kg dw	5	15	Note 1,2
Trichlorobenzene	mg/kg dw	1	10	
Total tetra- and pentachloro-benzenes	mg/kg dw	0,5	2	
Hexachlorobenzene	mg/kg dw	0,035	2	
Dichloromethane	mg/kg dw	0,08	0,25	Note 1,2
Dibromochloromethane	mg/kg dw	0,5	2	Note 1,2
Bromodichloromethane	mg/kg dw	0,06	1	Note 1,2
Trichloromethane	mg/kg dw	0,4	1,2	Note 1,2
Carbontetrachloride (Tetrachloromethane)	mg/kg dw	0,08	0,35	Note 1,2
1.2-dichloroethane	mg/kg dw	0,02	0,06	Note 1,2
1.2-dibromoethane	mg/kg dw	0,0015	0,025	Note 1,2
1,1,1-trichloroethane	mg/kg dw	5	30	Note 1,2
Trichlorethane (Tri)	mg/kg dw	0,2	0,6	Note 1,2
Tetrachloroethene (Per)	mg/kg dw	0,4	1,2	Note 1,2
Dinitrotoluen (2,4)	mg/kg dw	0,05	0,5	Note 2
PCB-7	mg/kg dw	0,008	0,2	PCB-7 are assumed to be 20% of PCBs-tot
Dioxin (TCDD-ekv WHO-TEQ)	mg/kg dw	0,00002	0,0002	Also include dioxin-like PCBS
PAH-L	mg/kg dw	3	15	PAH with low molecular weight

PAH-M	mg/kg dw	3,5	20	PAH with medium-high molecular weight. Revised June 2016.
PAH-H	mg/kg dw	1	10	PAH with high molecular weight
Benzene	mg/kg dw	0,012	0,04	Note 1,2
Toluene	mg/kg dw	10	40	Note 1,2
Ethylbenzene	mg/kg dw	10	50	Note 1,2
Xylene	mg/kg dw	10	50	Note 1,2
Aliphatic fraction >C5-C8	mg/kg dw	25	150	Note 1,2. Revised June 2016.
Aliphatic fraction >C8-C10	mg/kg dw	25	120	Note 1. Revised June 2016.
Aliphatic fraction >C10-C12	mg/kg dw	100	500	Note 1
Aliphatic fraction >C12-C16	mg/kg dw	100	500	
Aliphatic fraction >C5-C16	mg/kg dw	100	500	Sum of the aliphatic fractions above
Aliphatic fraction >C16-C35	mg/kg dw	100	1000	
Aromatic fraction >C8-C10	mg/kg dw	10	50	
Aromatic fraction >C10-C16	mg/kg dw	3	15	
Aromatic fraction >C16-C35	mg/kg dw	10	30	
MTBE	mg/kg dw	0,2	0,6	Note 1,2
DDT, DDD, DDE	mg/kg dw	0,1	1	New, June 2016.
Aldrine-Dieldrine	mg/kg dw	0,02	0,18	New, June 2016.
Quintozene-Pentachloroaniline	mg/kg dw	0,12	0,4	New, June 2016.
Organotin compounds	mg/kg dw	0,25	0,5	New, June 2016.
Tributyltin (TBT)	mg/kg dw	0,15	0,3	New, June 2016.
Dibutyltin (DBT)	mg/kg dw	1,5	5	New, June 2016.
Monobutyltin (MBT)	mg/kg dw	0,25	0,8	New, June 2016.
Irgarol	mg/kg dw	0,004	0,015	New, June 2016.
Diuron	mg/kg dw	0,025	0,08	New, June 2016.

Note 1. Substances that may be present in soil air. Additional analyses of soil air and indoor air are recommended.
Note 2. Substances that may be present in the groundwater. Additional analyses of groundwater are recommended.

Appendix 1. Guideline and limit values

Table 2. Dutch soil intervention values (RIVM 2013)

Parameter	Unit	Intervention values	Comments
Concentrations in soil are shown for standard soil (10% organic matter and 25% clay)			
Cyanide (complex)	mg/kg d.w.	50	
Cyanide (free)	mg/kg d.w.	20	
Thiocyanate	mg/kg d.w.	20	
Phenol	mg/kg d.w.	14	
Cresols (sum)	mg/kg d.w.	13	
Monochlorophenols (sum)	mg/kg d.w.	5,4	
Dichlorophenols (sum)	mg/kg d.w.	22	
Trichlorophenols (sum)	mg/kg d.w.	22	
Tetrachlorophenols (sum)	mg/kg d.w.	21	
Pentachlorophenol	mg/kg d.w.	12	
Monochlorobenzene	mg/kg d.w.	15	
Dichlorobenzenes (sum)	mg/kg d.w.	19	
Trichlorobenzenes (sum)	mg/kg d.w.	11	
Tetrachlorobenzenes (sum)	mg/kg d.w.	2,2	
Pentachlorobenzenes	mg/kg d.w.	6,7	
Hexachlorobenzene	mg/kg d.w.	2	
Dichloromethane	mg/kg d.w.	3,9	
Trichloromethane	mg/kg d.w.	5,6	
Carbon Tetrachloride (Tetrachloromethane)	mg/kg d.w.	0,7	
1.2-dichloroethane	mg/kg d.w.	6,4	
1,1,1-trichloroethane	mg/kg d.w.	15	
Trichlorethane (Tri)	mg/kg d.w.	2,5	
Tetrachloroethene (Per)	mg/kg d.w.	8,8	
Monochloroethene (Vinylchloride)	mg/kg d.w.	0,1	
1,1-dichlororethane	mg/kg d.w.	15	
1,1-dichlororethene	mg/kg d.w.	0,3	
1,2-dichloroethene (sum)	mg/kg d.w.	1	
Dichloropropanes (sum)	mg/kg d.w.	2	
1,1,2-trichloroethane	mg/kg d.w.	10	
PCB (sum 7)	mg/kg d.w.	1	
Dioxin (sum I-TEQ)	mg/kg d.w.	0,00018	
Monochloroanilines (sum)	mg/kg d.w.	50	
Chloronaphthalene (sum)	mg/kg d.w.	23	
PAHs (total (sum 10)	mg/kg d.w.	40	
Benzene	mg/kg d.w.	1,1	
Toluene	mg/kg d.w.	32	
Ethylbenzene	mg/kg d.w.	110	
Xylenes (sum)	mg/kg d.w.	0,2	
Styrene (vinylbenzene)	mg/kg d.w.	86	
Mineral oil	mg/kg d.w.	5000	
Chlorodane (sum)	mg/kg d.w.	4	
DDT (sum)	mg/kg d.w.	1,7	
DDE (sum)	mg/kg d.w.	2,3	
DDD (sum	mg/kg d.w.	34	
Aldrin	mg/kg d.w.	0,32	
Drins (sum)	mg/kg d.w.	4	
α-endosulphan	mg/kg d.w.	4	
α-HCH	mg/kg d.w.	17	
β-HCH	mg/kg d.w.	1,6	
γ-HCH (lindane)	mg/kg d.w.	1,2	
Heptachlor	mg/kg d.w.	4	
Heptachlor epoxide (sum)	mg/kg d.w.	4	
Organotin compounds (sum	mg/kg d.w.	2,5	
MCPA	mg/kg d.w.	4	
Atrazine	mg/kg d.w.	0,71	
Carbaryl	mg/kg d.w.	0,45	
Carbofuran	mg/kg d.w.	0,017	
Asbestos	mg/kg d.w.	100	
Cyclohexanone	mg/kg d.w.	150	
Dimethyl phthalate	mg/kg d.w.	82	
Diethyl phthalate	mg/kg d.w.	53	
Di-isobutyl phthalate	mg/kg d.w.	17	
Dibutyl phthalate	mg/kg d.w.	36	
Butyl benzyl phthalate	mg/kg d.w.	48	
Dihexyl phthalate	mg/kg d.s.	220	

Di(2-ethylhexyl)phthalate	mg/kg d.w.	60	
Pyridine	mg/kg d.w.	11	
Tetrahydofuran	mg/kg d.w.	7	
Tetrahydrothiophene	mg/kg d.w.	8,8	
Tribromomethane (bromoform)	mg/kg d.w.	75	

Appendix 1. Guideline and limit values

Tabel 3. Limit values to determine chemical classification of surface waters (**HVMFS 2015:4**).

Limit values to determine chemical classification of surface waters (HVMFS 2015:4)										Blue colour indicate Swedish limit values.
Name of substance	**Type of substanc e**	**CAS number**	**AA-EQS (annual average)**	**AA-EQS (annual average)**	**MAC-EQS (maximum allowable concentration)**	**MAC-EQS (maximum allowable concentration)**	**EQS**	**EQS**	**EQS**	**Comment**
			Inland surface waters: Inland surface waters encompass rivers and lakes and related artificial or heavily modified water bodies.	Other surface waters	Inland surface waters: Inland surface waters encompass rivers and lakes and related artificial or heavily modified water bodies.	Other surface waters	Inland surface waters: Biota: Unless explicitly indicated, the biota EQS refer to fish muscle.	Other surface waters: Biota: Unless explicitly indicated , the biota EQS refer to fish muscle.	Sediment : Swedish EQS	
			µg/L	*µg/L*	*µg/L*	*µg/L*	*µg/kg (ww)*	*µg/kg (ww)*	*µg/kg (dw)*	
Alachlor	priority substance	15972-60-8	0,3	0,3	0,7	0,7				
Anthracene	priority substance	120-12-7	0,1	0,1	0,1	0,1			24	Sediment-EQS refers to 5 % organic C. Normalisation is needed when sediment organic content deviates from 5 %.
Atrazine	priority substance	1912-24-9	0,6	0,6	2	2				
Benzene	priority substance	71-43-2	10	8	50	50				
Brominated diphenylethers	priority substance	32534-81-9	4,9 10-8	2,4 10-9	0,14	0,014	0,0085			For the group of priority substances covered by

										brominated diphenylethers (No 5), the EQS should be compared with the sum of the concentrations of congener numbers 28, 47, 99, 100, 153 and 154.
Cadmium and its compounds	priority substance	7440-43-9	≤ 0,08 (Class 1)	0,2	≤ 0,45 (Class 1)	≤ 0,45 (Class 1)			2300	EQS refers to dissolved concentration, i.e. sample filtrated though 0,45 µm-filter. For Cadmium and its compounds (No 6) the EQS values vary depending on the hardness of the water as specified in five class categories (Class 1: <40 mg CaCO3/l, Class 2: 40 to <50 mg CaCO3/l, Class 3: 50 to <100 mg CaCO3/l, Class 4: 100 to <200 mg CaCO3/l and Class 5: ≥200 mg CaCO3/l).
(depending on water hardness classes)	priority substance		0,08 (Class 2)		0,45 (Class 2)	0,45 (Class 2)				
			0,09 (Class 3)		0,6 (Class 3)	0,6 (Class 3)				
			0,15 (Class 4)		0,9 (Class 4)	0,9 (Class 4)				
			0,25 (Class 5)		1,5 (Class 5)	1,5 (Class 5)				
Carbon-tetrachloride	priority substance	56-23-5	12	12	not applicable	not applicable				This substance is not a priority substance but one of the other

										pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.
C10-13 Chloroalkanes	priority substance	85535-84-8	0,4	0,4	1,4	1,4	17000			No indicative parameter is provided for this group of substances. The indicative parameter(s) must be defined through the analytical method.
Chlorfenvinphos	priority substance	470-90-6	0,1	0,1	0,3	0,3				
Chlorpyrifos (Chlorpyrifos-ethyl)	priority substance	2921-88-2	0,03	0,03	0,1	0,1				
Cyclodiene pesticides:	priority substance		Σ = 0,01	Σ = 0,005	not applicable	not applicable				
Aldrin	priority substance	309-00-2								This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.
Dieldrin	priority substance	60-57-1								This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.

Endrin	priority substance	72-20-8								This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.
Isodrin	priority substance	465-73-6								This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.
DDT total	priority substance	not applicable	0,025	0,025	not applicable	not applicable				This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009. DDT total comprises the sum of the isomers 1,1,1 trichloro 2,2 bis (p chlorophenyl) ethane (CAS number 50 29 3; EU number 200 024 3); 1,1,1 trichloro 2 (o chlorophenyl) 2 (p chlorophenyl) ethane (CAS

										number 789 02 6; EU Number 212 332 5); 1,1-dichloro 2,2 bis (p chlorophenyl) ethylene (CAS number 72 55 9; EU Number 200 784 6); and 1,1 dichloro 2,2 bis (p chlorophenyl) ethane (CAS number 72 54 8; EU Number 200 783 0).
para-para-DDT	priority substance	50-29-3	0,01	0,01	not applicable	not applicable				This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.
1,2-Dichloroethane	priority substance	107-06-2	10	10	not applicable	not applicable				
Dichloromethane	priority substance	75-09-2	20	20	not applicable	not applicable				
Di(2-ethylhexyl)-phthalate (DEHP)	priority substance	117-81-7	1,3	1,3	not applicable	not applicable	3000 for crustaceans and cephalopods			
Diuron	priority substance	330-54-1	0,2	0,2	1,8	1,8				
Endosulfan	priority substance	115-29-7	0,005	0,0005	0,01	0,004				
Fluoranthene	priority substance	206-44-0	0,0063	0,0063	0,12	0,12	30 for crustaceans and cephalopods		2000	Sediment-EQS refers to 5 % organic C. Normalisation is needed when sediment organic content deviates from 5 %.
Hexachloro-benzene	priority substance	118-74-1			0,05	0,05	10			

Hexachloro-butadiene	priority substance	87-68-3			0,6	0,6	55			
Hexachloro-cyclohexane	priority substance	608-73-1	0,02	0,002	0,04	0,02				
Isoproturon	priority substance	34123-59-6	0,3	0,3	1	1				
Lead and its compounds	priority substance	7439-92-1	1,213	1,3	14	14			Inland surface waters 130 000, Other surface waters 120 000	EQS refers to dissolved concentration, i.e. sample filtrated though 0,45 µm-filter. AA-EQS for inland water refers to bioavailable concentrations of the substance.
Mercury and its compounds	priority substance	7439-97-6			0,07	0,07	20			EQS refers to dissolved concentration, i.e. sample filtrated though 0,45 µm-filter.
Naphthalene	priority substance	91-20-3	2	2	130	130				
Nickel and its compounds	priority substance	7440-02-0	413	8,6	34	34				EQS refers to dissolved concentration, i.e. sample filtrated though 0,45 µm-filter. AA-EQS for inland water refers to bioavailable concentrations of the substance.
Nonylphenols (4-Nonylphenol)	priority substance	84852-15-3	0,3	0,3	2	2				
Octylphenols ((4-(1,1',3,3'-tetramethylbutyl)-phenol))	priority substance	140-66-9	0,1	0,01	not applicable	not applicable				
Pentachlorobenzene	priority substance	608-93-5	0,007	0,0007	not applicable	not applicable	370			
Pentachlorophenol	priority substance	87-86-5	0,4	0,4	1	1				

Polyaromatic hydrocarbons (PAH)	priority substance	not applicable	not applicable	not applicable	not applicable	not applicable				For the group of priority substances of polyaromatic hydrocarbons (PAH) (No 28), the biota EQS is based on the toxicity of benzo(a)pyrene, which should be measured as a marker for the other PAHs, and whose concentration should be compared with the EQS. The AA-EQS in water is a corresponding value.
Benzo(a)pyrene	priority substance	50-32-8	1,7 10-4	1,7 10-4	0,27	0,027	5 for crustaceans and cephalopods, (10 for molluscs, 2 for fish)			
Benzo(b)fluor-anthene	priority substance	205-99-2			0,017	0,017				
Benzo(k)fluor-anthene	priority substance	207-08-9			0,017	0,017				
Benzo(g,h,i)-perylene	priority substance	191-24-2			8,2 10-3	8,2 10-4				
Indeno(1,2,3-cd)-pyrene	priority substance	193-39-5								
Simazine	priority substance	122-34-9	1	1	4	4				
Tetrachloro-ethylene	priority substance	127-18-4	10	10	not applicable	not applicable				This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.

Trichloro-ethylene	priority substance	79-01-6	10	10	not applicable	not applicable				This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.
Tributyltin compounds (Tributhyltin-cation)	priority substance	36643-28-4	0,0002	0,0002	0,0015	0,0015			1,6	Sediment-EQS refers to 5 % organic C. Normalisation is needed when sediment organic content deviates from 5 %.
Trichloro-benzenes	priority substance	12002-48-1	0,4	0,4	not applicable	not applicable				
Trichloro-methane	priority substance	67-66-3	2,5	2,5	not applicable	not applicable				
Trifluralin	priority substance	1582-09-8	0,03	0,03	not applicable	not applicable				
Dicofol	priority substance	115-32-2	1,3 10-3	3,2 10-5	not applicable10	not applicable10	33			
Perfluorooctane sulfonic acid and its derivatives (PFOS)	priority substance	1763-23-1	6,5 10-4	1,3 10-4	36	7,2	9,1			
Quinoxyfen	priority substance	124495-18-7	0,15	0,015	2,7	0,54				
Dioxins and dioxin-like compounds	priority substance	See footnote 10 in Annex X to Directive 2000/60/EC					Sum of PCDD+PCDF+PCB-DL 0,0065 µg.kg-1 TEQ			PCDD: polychlorinated dibenzo-p-dioxins; PCDF: polychlorinated dibenzofurans; PCB-DL: dioxin-like polychlorinated biphenyls; TEQ: toxic equivalents.
Aclonifen	priority substance	74070-46-5	0,12	0,012	0,12	0,012				

Bifenox	priority substance	42576-02-3	0,012	0,0012	0,04	0,004					
Cybutryne	priority substance	28159-98-0	0,0025	0,0025	0,016	0,016					
Cypermethrin	priority substance	52315-07-8	8 10-5	8 10-6	6 10-4	6 10-5					
Dichlorvos	priority substance	62-73-7	6 10-4	6 10-5	7 10-4	7 10-5					
Hexabromocyclododecane (HBCDD)	priority substance	See footnote 12 in Annex X to Directive 2000/60/EC	0,0016	0,0008	0,5	0,05	167				
Heptachlor and heptachlor epoxide	priority substance	76-44-8 / 1024-57-3	2 10-7	1 10-8	3 10-4	3 10-5	6,7 10-3				
Terbutryn	priority substance	886-50-0	0,065	0,0065	0,34	0,034					
Ammonia (NH3-N) (4)	other pollutant	7664-41-7	1	0,66	6,8	5,7					Ammonia concentration, as ammonia-nitrogen (NH3-N), calculated from the concentration of ammoniumnitrogen (NH4-N), temperature and pH:– Conc NH3-N = fraction NH3-N * halt NH4-N, – Fraction NH3-N = 1/(10^(pKa-pH)+1), – pKa = 0,0901821 + 2729,92 / T (T = temperature expressed as Kelvin).
Arsenic	other pollutant	7440-38-2	0,5	0,55	7,9	1,1					
Bentazone	other pollutant	25057-89-0	27		4700						
Bisphenol A	other pollutant	65873	1,6	0,11	2,7						

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Bronopol	other pollutant	52-51-7	0,7	0,3							
C14-17 Chloroalkanes, MCCP	other pollutant	85535-85-9	1	0,2							
Diflufenican	other pollutant	83164-33-4	0,01								
Diclofenac	other pollutant	15307-86-5	0,1	0,01							
Dichlorprop-P	other pollutant	15165-67-0	10								
17alpha-ethinylestradiol	other pollutant	57-63-6	0,000035	0,000007							
Glyphosate	other pollutant	1071-83-6	100								
Chloridazon	other pollutant	1698-60-8	10								
Copper	other pollutant	7440-50-8	0,5 biological available	biological available: 2,6 for Västerhavet, 0,87 for the Baltic Sea (5)							The value in the table (biological available) should be compared to the measured concentration of dissolved copper multiplited with (DOC/2)^0,6136. If site-specific values for DOC is missing, the value 4,3 µg Cu/l should be used for Västerhavet and 1,45 µg Cu/l for the Baltic Sea.
Chrome (total halt) (5)	other pollutant	1333-82-0; 7775-11-3; 10588-01-9; 7789-09-5; 7778-50-9	3,4	3,4							The value is based on Cr VI.

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MCPA	other pollutant	94-74-6	1							
Mekoprop & Mekoprop- P	other pollutant	7085-19-0 & 16484-77-8	20							
Metribuzin	other pollutant	21087-64-9	0,08							
Metsulfuronmetyl	other pollutant	74223-64-6	0,02							
Nonylphenolethoxylates	other pollutant		0,3 NP-TEQ	0,3 NP-TEQ						The total concentration of nonylfenol (NP) and NP-eqvivalents is calculated according to the following formula: total concentration = Σ(Cx * TEF). TEF-värden: NP = 1; NP1EO = 0,5; NP2EO = 0,5; NPnEO (3 >=n<=8) = 0,5; NPnEO (n >= 9) = 0,005; NP1EC = 0,005; NP2EC = 0,005.
Pirimikarb	other pollutant	23103-98-2	0,09							
Sulfusulfuron	other pollutant	141776-32-1	0,05							
Triclosan	other pollutant	3380-34-5	0,1	0,01						
Uran	other pollutant	7440-61-1	0,17	0,17	8,6	8,6				
Zinc	other pollutant	7440-66-6	5,5 biotillgänglig t	3,4 for Västerhavet , 1,1 for the Baltic Sea						

17beta-estradiol	other pollutant	50-28-2	0,0004	0,00008						
Sum of nondioxinlike PCBs (28, 52, 101, 138, 153 and 180)	other pollutant						125	75		

Table 4. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life for freshwater (http://st-ts.ccme.ca/en/index.html)

	Chemical groups	**Concentration (µg/kg dry weight) ISQG**	**Concentration (µg/kg dry weight) PEL**	**Date**
2-Methylnaphthalene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	20.2	201	1998
Acenaphthene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	6.71	88.9	1998
Acenaphthylene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	5.87	128	1998
Anthracene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	46.9	245	1998
Aroclor 1254 PCBs	Organic Polyaromatic compounds Polychlorinated biphenyls	60	340	2001
Arsenic CASRN none	Inorganic Metals	5900	17 000	1998
Benz(a)anthracene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	31.7	385	1998
Benzo(a)pyrene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	31.9	782	1998
Cadmium CASRN 7440439	Inorganic Metals	600	3500	1997
Chlordane	Organic Pesticides Organochlorine	4.5	8.87	1998
Chromium (total) CASRN 7440-47-3	Inorganic Metals	37 300	90 000	1998
Chrysene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	57.1	862	1998
Copper	Inorganic Metals	35 700	197 000	1998
Dibenz(a,h)anthracene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	6.22	135	1998
Dichloro diphenyl dichloroethane, 2,2-Bis (p-chlorophenyl)-1,1-dichloroethane DDD	Organic Pesticides Organochlorine compounds	3.54	8.51	1998

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Chemical name	Chemical groups	Concentration (µg/kg dry weight) ISQG	Concentration (µg/kg dry weight) PEL	Date
Dichloro diphenyl ethylene, 1,1-Dichloro-2,2-bis(p-chlorophenyl)-ethene DDE	Organic Pesticides Organochlorine compounds	1.42	6.75	1998
Dichloro diphenyl trichloroethane; 2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane DDT (total)	Organic Pesticides Organochlorine compounds	1.19	4.77	1998
Dieldrin	Organic Pesticides Organochlorine compounds	2.85	6.67	1998
Endrin	Organic Pesticides Organochlorine compounds	2.67	62.4	1998
Fluoranthene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	111	2355	1998
Fluorene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	21.2	144	1998
Heptachlor Heptachlor epoxide	Organic Pesticides Organochlorine compounds	0.6	2.74	1998
Hexachlorocyclohexane Lindane	Organic Pesticides Organochlorine compounds	0.94	1.38	1998
Lead	Inorganic Metals	35 000	91 300	1998
Mercury CASRN 7439976	Inorganic Metals	170	486	1997
Naphthalene PAHs	Organic Polyaromatic compounds Polycyclic aromatic	34.6	391	1998
Nonylphenol and its ethoxylates CASRN 84852153	Organic Nonylphenol and its ethoxylates	1400	No data	2002
Phenanthrene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	41.9	515	1998
Polychlorinated biphenyls PCBs	Organic Polyaromatic compounds Polychlorinated biphenyls	34.1	277	2001
Polychlorinated dibenzo-pdioxins/ dibenzo furans PCDDs, PCDFs	Organic Polyaromatic compounds Polychlorinated dioxins and furans	0.85 ng TEQ/kg dry weight	21.5 ng TEQ/kg dry weight	2001
Pyrene PAHs	Organic Polyaromatic compounds Polycyclic aromatic hydrocarbons	53	875	1998
Chemical name	**Chemical groups**	**Concentration (µg/kg dry**	**Concentration (µg/kg dry**	**Date**

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		weight) **ISQG**	**weight)** **PEL**	
Toxaphene	Organic Pesticides Organochlorine compounds	0.1	No PEL derived	2002
Zinc	Inorganic Metals	123 000	315 000	1998

Table 5. Swedish Guideline Values and Trend Reversal Starting Point Values for Groundwater (SGU- FS 2016:1)

Parameter	**Unit**	**Guideline value**	**Trend Reversal Starting Point**
Nitrate	mg/l	50	20
Nitrite	mg/l	0,5	0,1
Phosphate	mg/l	0,6	0,1
Pesticides	µg/l	0,1 0,5 total	Detected
Chloride	mg/l	100	50; West Coast 75
Conductivity	mS/m	150	75
Sulphate	mg/l	100	50
Ammonium	mg/l	1,5	0,5
Arsenic	µg/l	10	5
Cadmium	µg/l	5	1
Lead	µg/l	10	2
Mercury	µg/l	1	0,05
Trichloroethylene + Tetrachloroethylene	µg/l	10	2
Chloroform (Trichloromethane)	µg/l	100	50
1,2- dichloroethane	µg/l	3	0,5
Benzene	µg/l	1	0,2
Benzo(a)pyrene	ng/l	10	2
Sum of 4 PAH:, Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(ghi)perylene Indeno(1,2,3-cd)pyrene	ng/l	100	20
PFAS (			

Table 6. Criteria for Environmental Quality Assessment for Groundwater, Geological Survey of Sweden, 2013:01

Parameter	Unit	Class 1	Class 2	Class 3	Class 4	Class 5	Comment
Arsenic	µg/l	<1	1-2	2-5	5-10	≥10	
Lead	µg/l	<0,5	0,5-1	1-2	2-10	≥10	
Cadmium	µg/l	<0,1	0,1-0,5	0,5-1	1-5	≥5	
Copper	mg/l	<0,02	0,02-0,2	0,2-1	1-2	≥2	
Chromium totalt	µg/l	<0,5	0,5-5	5-10	10-50	≥50	
Mercury	µg/l	<0,005	0.005-0,01	0,01-0,05	0,05-1	≥1	
Nickel	µg/l	<0,5	0,5-2	2-10	10-20	≥20	
Zinc	mg/l	<0,005	0,005-0,01	0,01-0,1	0,1-1	≥1	
Trichloromethane (chloroform)	µg/l	<1	1-20	20-50	50-100	≥100	
1.2-dichloroethane	µg/l	<0,02	0,02-0,1	0,1-0,5	0,5-3	≥3	
Trichlorethane (Tri) Tetrachloroethene (Per)	µg/l	<0,1	0,1-1	1-2	2-10	≥10	Sum of trichloroethane and tetrachloroethane
Sum PAH4	µg/l	<0,001	0,001-0,01	0,01-0,02	0,02-0,1	≥0,1	Sum of benzo(b)flouranthene, benzo(k)flouranthene, benzo(ghi)perylene and indeno(1,2,3-cd)pyrene)
Benzo(a)pyrene	µg/l	<0,0005	0,0005-0,001	0,001-0,002	0,002-0,01	≥0,01	
Benzene	µg/l	<0,02	0,02-0,1	0,1-0,2	0,2-1	≥1	
Pesticides (sum)	µg/l	<0,01	0,01-0,025	0,025-0,05	0,05-0,1	≥0,1/0,5	The value 0,5 µg/l refers to the sum of all measured pesticides (including metabolites)

Table 7. Dutch groundwater target and intervention values, VROM 2000

Parameter	Unit	Target values		Intervention values	Comment
		Shallow (Metals)	Deep (Metals)		
Antimony	µg/l	-	0,15	20	
Arsenic	µg/l	10	7,2	60	
Barium	µg/l	50	200	625	
Lead	µg/l	15	1,7	75	
Cadmium	µg/l	0,4	0,06	6	
Cobalt	µg/l	20	0,7	100	
Copper	µg/l	15	1,3	75	
Chromium	µg/l	1	2,5	30	
Mercury	µg/l	0,05	0,01	0,3	
Molybdenum	µg/l	5	3,6	300	
Nickel	µg/l	15	2,1	75	
Zinc	µg/l	65	24	800	
Cyanide (complex)	µg/l	10		1500	
Cyanide (free)	µg/l	5		1500	
Thiocyanate	µg/l	-		1500	
Phenol	µg/l	0,2		2000	
Cresols (sum)	µg/l	0,2		200	
Monochlorophenols (sum)	µg/l	0,3		100	
Dichlorophenols (sum)	µg/l	0,2		30	
Trichlorophenols (sum)	µg/l	0,03		10	
Tetrachlorophenols (sum)	µg/l	0,01		10	
Pentachlorophenol	µg/l	0,04		3	
Monochlorobenzene	µg/l	7		180	
Dichlorobenzenes (sum)	µg/l	3		50	
Trichlorobenzenes (sum)	µg/l	0,01		10	
Tetrachlorobenzenes (sum)	µg/l	0,01		2,5	
Pentachlorobenzenes	µg/l	0,03		1	
Hexachlorobenzene	µg/l	0,00009		0,5	
Dichloromethane	µg/l	0,01		1000	
Trichloromethane (chloroform)	µg/l	6		400	
Carbon Tetrachloride (Tetrachloromethane)	µg/l	0,01			
1.2-dichloroethane	µg/l	7		400	
1,1,1-trichloroethane	µg/l	0,01		300	
Trichlorethane (Tri)	µg/l	24		500	
Tetrachloroethene (Per)	µg/l	0,01		10	
Monochloroethene (Vinylchloride)	µg/l	0,01		5	
1,1-dichlororethane	µg/l	7		900	
1,1-dichlororethene	µg/l	0,01		10	
1,2-dichloroethene (sum)	µg/l	0,01		20	
Dichloropropanes (sum)	µg/l	0,8		80	
1,1,2-trichloroethane	µg/l	0,01		130	
PCB (sum 7)	µg/l	0,01		0,01	
Dioxin (sum I-TEQ)	µg/l	-		N/A	
Monochloroanilines (sum)	µg/l	-		30	
Chloronaphthalene (sum)	µg/l	-		6	
Naphthalene	µg/l	0,01		70	
Phenanthrene	µg/l	0,003		5	
Anthracene	µg/l	0,0007		5	
Parameter	**Unit**	**Target values**		**Intervention values**	**Comment**
Flouranthene	µg/l	0,003		1	
Chrysene	µg/l	0,003		0,2	
Benzo(a)pyrene	µg/l	0,0001		0,5	
Benzo(a)anthracene	µg/l	0,0005			
Benzo(k)flouranthene	µg/l	0,0004		0,05	
Indeno(1,2,3,cd)pyrene	µg/l	0,0004		0,05	
Benzo(ghi)perylene	µg/l	0,0003		0,05	
Benzene	µg/l	0,2		30	
Toluene	µg/l	7		1000	
Ethylbenzene	µg/l	4		150	

Xylenes (sum)	µg/l	0,2	70	
Styrene (vinylbenzene)	µg/l	6	300	
Mineral oil	µg/l	50	600	
Chlorodane (sum)	µg/l	0,02 ng/l	0,2	
DDT/DDE/DDD (sum)	µg/l	0,004 ng/l	0,01	
Aldrin	µg/l	0,009 ng/l	-	
Dieldrin	µg/l	0,1 ng/l	-	
Endrin	µg/l	0,04 ng/l	-	
Drins (sum)	µg/l	-	0,1	
α-endosulphan	µg/l	0,2 ng/l	5	
α-HCH	µg/l	33 ng/l	-	
β-HCH	µg/l	8 ng/l	-	
γ-HCH (lindane)	µg/l	9 ng/l	-	
HCH-compounds (sum)	µg/l	0,05	1	Sum of the HCH-compounds above.
Heptachlor	µg/l	0,005 ng/l	0,3	
Heptachlor epoxide (sum)	µg/l	0,005 ng/l	3	
Organotin compounds (sum	µg/l	0,05-16 ng/l	0,7	
MCPA	µg/l	0,02	50	(chlorophenoxy-acetic acid herbicides)
Atrazine	µg/l	29 ng/l	150	
Carbaryl	µg/l	2 ng/l	50	
Carbofuran	µg/l	9 ng/l	100	
Cyclohexanone	µg/l	0,5	15000	
Phthalates (sum)	µg/l	0,5	5	
Pyridine	µg/l	0,5	30	
Tetrahydofuran	µg/l	0,5	300	
Tetrahydrothiophene	µg/l	0,5	5000	
Tribromomethane (bromoform)	µg/l	-	630	

Table 8. Proposed groundwater limit values for remediation of contaminated gas stations and diesel plants, SPI 2010.

Parameter	Unit	Drinking water	Vapors in buildings	Irrigation	Surface water	Wetlands
Lead	mg/l	0,005		0,03	0,05	0,5
PAH-L	mg/l	0,01	2	0,08	0,12	0,04
PAH-M	mg/l	0,002	0,01	0,01	0,005	0,015
PAH-H	mg/l	0,00005	0,3	0,006	0,0005	0,003
Benzene	mg/l	0,0005	0,05	0,4	0,5	1
Toluene	mg/l	0,04	7	0,6	0,5	2
Ethylbenzene	mg/l	0,03	6	0,4	0,5	0,7
Xylenes (sum)	mg/l	0,25	3	4	0,5	1
Aliphatic fraction >C5-C8	mg/l	0,1	3	1,5	0,3	1,5
Aliphatic fraction >C8-C10	mg/l	0,1	0,1	1,5	0,15	1
Aliphatic fraction >C10-C12	mg/l	0,1	0,025	1,2	0,3	1
Aliphatic fraction >C12-C16	mg/l	0,1	-	1	3	1
Aliphatic fraction >C16-C35	mg/l	0,1	-	1	3	1
Aromatic fraction >C8-C10	mg/l	0,07	0,8	1	0,5	0,15
Aromatic fraction >C10-C16	mg/l	0,01	10	0,1	0,12	0,015
Aromatic fraction >C16-C35	mg/l	0,002	25	0,07	0,005	0,015
MTBE	mg/l	0,02	20	0,2	5	15

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Table 9. Regulation for Drinking water (SLVFS 2001:30)

Parameter	Unit	Inexpedient	Comment
Antimony	µg/l	5	
Arsenic	µg/l	10	
Barium	mg/l	1	
Lead	µg/l	10	
Cadmium	µg/l	5	
Copper	mg/l	2	
Chromium totalt	µg/l	50	
Mercury	µg/l	1	
Nickel	µg/l	20	
Selenium	µg/l	10	
Cyanide (complex)	µg/l	50	
Trichloromethane	µg/l	100	
Trichlorethane (Tri) Tetrachloroethene (Per)	µg/l	10	Sum of trichloroethane and tetrachloroethane
Monochloroethene (Vinylchloride)	µg/l	0,5	
1,2-dichloroethane	µg/l	3	
Trihalomethanes	µg/l	100	Sum of chloroform, bromoform, dibromochloromethane, bromodichloromethane
Pesticides (individual)	µg/l	0,1	Regarding aldrin, dieldrin, heptachlor and heptachlor epoxide the limit value is 0,030 µg/l.
Pesticides (sum)	µg/l	0,5	
Benzene	µg/l	1,0	
Benzo(a)pyrene)	µg/l	0,01	
Sum of 4 PAH:, Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(ghi)perylene Indeno(1,2,3-cd)pyrene	µg/l	0,1	
Nitrate	mg/l	50	
Nitrite	mg/l	0,5	
Boron	mg/l	1	
Fluoride	mg/l	1,5	