TRANSFERE OF CZECH KNOWLEDGE:

Strengthening National Capacities on Comprehensive Chemicals (Persistent Organic Pollutants) Contaminated Site Assessment in Armenia

Analytical Report on Sampling on Nubarashen Site

Brno, December 2013

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Analytical Report on Sampling on Nubarashen Site

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LIST OF ABBREVIATIONS

AMA	Advanced Mercury Analyser
BC	Basel Convention
BRL	Basic Reference Level
DDD /DDE	Metabolites of DDT
DDT	Dichlorodiphenyltrichloroethane, p,p′-DDT= 4,4′-DDT, o,p´DDT=2,4'-DDT
GC-MS	Gas chromatography–mass spectrometry
GPS	Global Positioning System
HDPE	Hugh Density Polyethylen
HHR	Human Health Risk
HCH	Hexachlorocyclohexane
ICP-OES	Inductively Coupled Plasma atomic Emission Spectroscopy
MPL	Maximal Permissible Level
MWS	MicroWaveSensor
OCP	OrganoChlorine Pesticides
SC	Stockholm Convention

1. Introduction

The purpose of this report is to present an overview of the results of chemical analyses of soils collected at the site Nubarashen by the company GEOtest, a.s. within the project: TRANSFERE OF CZECH KNOWLEDGE: Strengthening National Capacities on Comprehensive Chemicals (Persistent Organic Pollutants) contaminated site assessment in Armenia. This report also includes the methodology of sampling at the site Nubarashen. The interpretation of the results of sampling was made with respect to the results of previous survey work and planned activities at the site (preparatory work and remediation).

2. Methodology

Sampling was carried out on the basis of a sampling plan (GEOtest, a.s., October 2013), which has been approved by the Client. During the field work, several small changes were made as compared with the sampling plan. The methodology of sampling is described in this chapter.

2.1 Target of Sampling

Target of sampling was the determination of contamination concentrations, to advance data on square and depth range of contamination. When doing so earlier survey works were respected and recommendations of „Gap analyses Conceptual Site Model Nubarashen Landfill – Draft“(Tauw, Oct. 2013) in order to avoid duplicity of sampling.

2.2 Range of Analyses

The 4,4'-DDT, 2,4'-DDT, 4,4'-DDD, 2,4'-DDD, 4,4'-DDE, 2,4'-DDE, α HCH, β HCH, γ HCH, δ HCH, Hg and As were determined in samples in dry matter.

2.3 Sampling Locations

To fill the data gap concerning the soil quality of landfill body itself and range of the depth of contamination spreading the soil was sampled. Composite soil samples of each soil layer of max 0.5 m were collected. Because of the lower penetration of the drilling technology, the assumed depth 2.5 m was rarely reached. Therefore, more holes were drilled along the toe of the landfill as compared with the plan to sample the soil forming the structural layers of the landfill below the level of the surrounding land.

To fill the gaps concerning the soil quality from the depth > 0.5 m below surface level around the landfill body but inside the fence areas identified as I, II, III, IV, V, VI, VII, VIII and IX were sampled. The composite soil samples of each soil layer of max 0.5 m were taken in each hole.

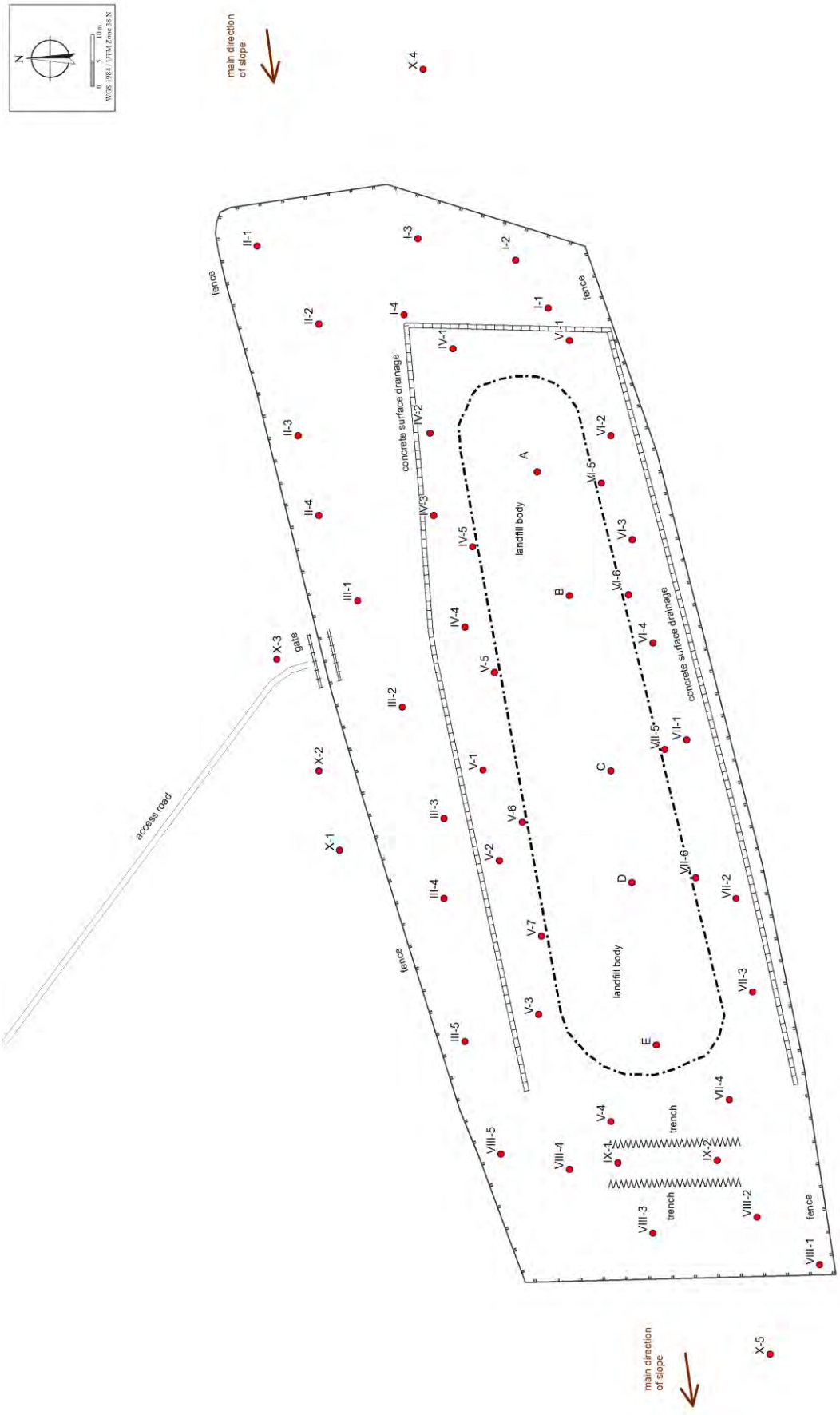
In order to verify potential contamination migration samples outside the fenced area were taken. Composite soil samples of soil layer of max 0.5 m were collected.

After collection of samples holes were backfilled with core material and clean soil (0.5 m from the surface). The landfill body holes were sealed with bentonite in a depth interval 0–1 m from the surface.

The position of holes is shown in the following picture.

Approximate location of holes

Fig 2.3-1



2.4 Subsurface Exploration Works

For the purposes of recording geological conditions, contamination at the site and sample collection, a total of 54 driven and dug holes were carried out.

Driven holes were carried out using a gouge auger with an external diameter of 45 mm of sampling tube. This device was driven by a pneumatic hammer of the brand Makita.

The holes were carried out to the maximum-possible depth permeable for this device.

Hand-dug holes were carried out in places in which the environment was stony and hard to permeable for mechanical drilling technology.

An overview of the holes made is given in the following table.

An overview of holes made — Table 2.4-1

Hole	WGS 84			Area	Depth (m)	Method of excavation	Date
	N	E	Elevation (m asl)				
A	40,142904	44,617771	1373	Landfill body	1.8	Gouge auger + pneumatic hammer	29.10.13
B	40,142861	44,617556	1368		2.5		
C	40,142806	44,617250	1369		2.0		
D	40,142778	44,617056	1369				
E	40,142745	44,616772	1362		2.1		
I-1	40,142889	44,618056	1370	Between landfill body and surface drainage	1.0		23.10.13
I-2	40,142933	44,618140	1374				
I-3	40,143063	44,618177	1375				
I-4	40,143081	44,618044	1382				
II-1	40,143277	44,618164	1376	Between surface drainage and fence	1.0		28.10.13
II-2	40,143194	44,618028	1376				
II-3	40,143222	44,617833	1374				
II-4	40,143194	44,617694	1373		0.8		
III-1	40,143143	44,617546	1370	Between surface drainage and fence			
III-2	40,143083	44,617361	1365				
III-3	40,143028	44,617167	1365		1.5		
III-4	40,143028	44,617028	1366				
III-5	40,143000	44,616778	1367		1.0		
IV-1	40,143016	44,617985	1318	Between landfill body and surface drainage	1.4		27.10.13
IV-2	40,143046	44,617838	1380				
IV-3	40,143042	44,617694	1373		1.3		
IV-4	40,143001	44,617500	1368		1.5		28.10.13
IV-5	40,142990	44,617640	1384		1.4		29.10.13
V-1	40,142796	44,616567	1368	Between landfill body and surface drainage	1.5		25.10.13
V-2	40,142664	44,616571	1366		1.0		25.10.13
V-3	40,142976	44,617252	1372		1.3		27.10.13
V-4	40,142954	44,617093	1375				
V-5	40,142902	44,616826	1370		1.5		30.10.13
V-6	40,142806	44,616639	1368				
V-7	40,142961	44,617421	1380		1.4		
VI-1	40,142924	44,617161	1375	Between landfill body and surface drainage	1.5		23.10.13
VI-2	40,142898	44,616962	1368				24.10.13
VI-3	40,142861	44,618001	1375				
VI-4	40,142806	44,617833	1378				
VI-5	40,142778	44,617653	1372		1.4		29.10.13
VI-6	40,142750	44,617472	1376				
VII-1	40,142818	44,617752	1376	Between landfill body and surface drainage	1.5		24.10.13
VII-2	40,142782	44,617557	1370		2.0		
VII-3	40,142705	44,617304	1373		1.5		
VII-4	40,142639	44,617028	1365		1.5		
VII-5	40,142617	44,616865	1359		1.4		29.10.13
VII-6	40,142648	44,616677	1362		1.5		30.10.13

Hole	WGS 84			Area	Depth (m)	Method of excavation	Date
	N	E	Elevation (m asl)				
VIII-1	40,142734	44,617287	1372	Between trench and fence	1.0		24.10.13
VIII-2	40,142693	44,617064	1375		0.8		27.10.13
VIII-3	40,142528	44,616389	1370		1.3		
VIII-4	40,142611	44,616472	1367		1.0		
VIII-5	40,142750	44,616444	1364				
IX-1	40,142861	44,616556	1367	Between trenches			
IX-2	40,142952	44,616582	1367				
X-1	40,143167	44,617111	1370	Behind the fence	0.5		28.10.13
X-2	40,143194	44,617250	1371				
X-3	40,143250	44,617444	1373				
X-4	40,143056	44,618472	1386		1.0	Dug hole	30.10.13
X-5	40,142594	44,616234	1364				

2.5 Collection of Samples

Samples from the driven and dug holes were collected as stratified from 0.5 m thick layers in maximum.

In areas between landfill body and fence where samples of soil were already taken and analysed by previous surveys, the samples were taken from a depth of 0.5–1.0 m (avoiding duplicity of sampling). When contamination was sensorially identified in 0.5–1.0 m depth, samples from the depth range 1.0–1.5 were taken in order to define the extent of contamination. If contamination was detected sensorially at the depth 1.0–1.5 as well, this procedure was repeated until the depth was reached at which contamination was not detected sensorially or at which the hole had to be terminated because of the impermeability of the geological environment.

In the landfill body the soil of structural layers of the landfill was sampled in 0.5 m intervals from the surface of the body down to the penetrable depth (2.5 m at maximum).

In all, 101 samples were collected. An overview of samples taken is shown in Table 2.5-1.

An overview of samples taken Table 2.5-1

Designation of hole	Depth range of sample collection (m)					Number of samples
	0–0.5	0.5–1	1–1.5	1.5–2	2–2.5	
A	x	x	x	1.5–1.8		4
B	x	x	x		x	4
C	x	x		x		3
D	x	x	x	x		4
E	x	x	x	1.5–2.1		4
I-1		x				1
I-2		x				1
I-3		x				1
I-4		x				1
II-1	x	x				2
II-2	x	x				2
II-3		x				1
II-4		0.5–0.8				1
III-1	x					1
III-2	x	0.5–0.8				2
III-3	x	x	x			3
III-4		x				1

Designation of hole	Depth range of sample collection (m)					Number of samples
	0–0.5	0.5–1	1–1.5	1.5–2	2–2.5	
III-5		x				1
IV-1		x	1–1.4			2
IV-2		x	1–1.4			2
IV-3		x	1–1.3			2
IV-4		x	x			2
IV-5		x	1–1.4			2
V-1		x	x			2
V-2		x	x			2
V-3		x	x			2
V-4		x	x			2
V-5		x	x			2
V-6		x	1.3–1.5			2
V-7		x	1–1.4			2
VI-1		x	x			2
VI-2		x	x			2
VI-3		x	x			2
VI-4		x	x			2
VI-5	x	x	1–1.3			3
VI-6		x	1–1.4			2
VII-1		x	x			2
VII-2		x	x	x		3
VII-3		x	x			2
VII-4		x	x			2
VII-5		x	1–1.4			2
VII-6		x	x			2
VIII-1		x				1
VIII-2		0.5–0.8				1
VIII-3		x				1
VIII-4		x				1
VIII-5		x				1
IX-1		x				1
IX-2		x				1
X-1	x					1
X-2	x					1
X-3	x					1
X-4	x					1
X-4		x				1
X-5	x	x				2
TOTAL	**16**	**50**	**29**	**5**	**1**	**101**

After sampling, stainless sampling sets (samplers, scoops, scrapers) were used. Homogenization of composite sample was done on stainless trays. Before every next collection (before going to the next collection location), all equipment was cleaned thoroughly and rinsed with distilled water, in order to remove contaminants from the surface of the sampler, and to dry it out.

Soil samples weighing at least 100 g were placed in thoroughly pre-washed and dry glass sample tubes. The sample tubes were thoroughly and watertightly closed and provide with a label containing substantial information.

Seventeen duplicate samples were taken in order to be handed out to the UNDP representative for comparative analyses. The list of duplicate samples is following:

1) A(0,5–1m)D
2) B(0,5–1m)D
3) C(0,5–1m)D
4) D(0,5–1m)D
5) E(0–0,5)D
6) III-2(0–0,5m)D
7) III-4(0,5–1m)D
8) III-5(0,5–1)D
9) IV-3(0,5–1m)D
10) IV-4(0,5–1m)D
11) IV-5(0,5–1)D
12) V-1(0,5–1m)D
13) V-3(1–1,3m)D
14) VI-2(0,5–1m)D
15) VI-3(0,5–1m)D
16) VI-6(0,5–1m)D
17) VII-5(0,5–1m)D

When selecting duplicate samples, the need to obtain a set of split samples was taken into account; this set will represent a wide range of OCP concentrations, i.e. from the lowest to the highest.

3. The Schedule of Sampling

The basic sampling position on site was installed at first. The sampling started preferably on the place of expected lowest concentrations of contaminants and on the places where bedrock was expected. This attitude prevents introduction of contamination to potentially clean areas and enable to modify the sampling plan. The sampling started on 23. 10. 2013 on Nubarashen site, works on site finished on 30. 10. 2013. The samples were sent to the Czech Republic to accredited laboratories of the GEOtest, a.s. company.

4. Sample Treatment

4.1 Ogranochlorinated Pesticides (DDT, DDE, DDD, HCHs)

The most common method for sample treatment was based on extraction of target compounds into mixture of Hexane and acetone followed by a group of cleaning steps. In this paragraph, the process of sample treatment which was used is listed.

A small amount of soil sample was dried on a glass mat at room temperature for at least 48 hours. After this time, 1 g of dry soil sample was placed into a 40 mL glass test-tube and 30 mL of a mixture of n-Hexane and Acetone (2:1) was added. The extraction was done in ultrasound water bath for 40 min. Then the extract was left in the same test-tube for next 8–12 hours. After this time, the decantation of extract into separating funnel was done. Then the test-tube with the soil wads rinsed again by 2 Ч 15 mL of n-Hexane and both volumes were also decanted into the same separating funnel. Approx. 40 mL of H_2SO_4 were added into a separating funnel and the mixture was shaken for 2–4 min intensively. Then the layer of the acid was let out and the extract in the separating funnel was shaken with 3 Ч40 mL of distilled water subsequently – 3rd water shaking was carried out with an addition of a small amount of $CaCO_3$ (one teaspoon) in order to neutralize the residual acid. The layer of the water was separated from the organic layer (extract) in the separating funnel in all three cases. Finally the organic layer was let out into beaker and the small amounts of $CaCO_3$ and anhydrous Na_2SO_4 (both approx. one teaspoon) were added into the extract in order to eliminate the residual water. Then the extract was filtered through anhydrous Na_2SO_4 placed in an analytical funnel. After

filtration, the extract was evaporated and concentrated to 0.5 mL and was finally analysed by GC-MS.

4.2 Metals (As, Hg)

A small amount of soil sample was dried on a glass mat at room temperature for at least 48 hours. After this time, 0.25 g of dry soil sample was placed into a Teflon mineralization cartridge. 5 mL of HNO_3 + 3 mL of 30% H_2O_2 were added into the cartridge and left to stand for 15–120 min, until reaction stopped. Then the microwave decomposition was done using a microwave mineralization device (MWS-2 speedwave) using a default program for soil decomposition. After the microwave decomposition process, the whole content of cartridge including soil was placed into a 50 mL flask and filled with distilled water to volume. Then, the content of flask was filtered to a test-tube and analysed by AMA 254 in the case of Hg and by ICP-OES in the case of As.

5. Sample Analysis

5.1 Ogranochlorinated Pesticides – GC-MS Analysis

GC-MS analysis was carried out with the Thermo Trace GC Ultra system equipped with a DB-5MS capillary column (dimensions: 60 m Ч 0.25 mm Ч 0.25 μm). The sample (1 μL) was injected in a splitless mode at 280°C. The carrier gas was ultrapure helium (99.99990%) set at the constant flow mode (1 mL/min). The temperature program was as follows: 5 min at 50°C, then with heat at 7°C/min to 300°C and held for 10 min. The transfer line temperature was set to 300°C. The mass spectrometer with an ion trap (Thermo ITQ 900) was operated in the electron-impact mode at 70 eV. The ion trap was operated in the scan mode in a range of molecular weights from 50–450. The temperature of ion source was set at 200°C.

5.2 As – Analysis by ICP-OES

The analysis of As was carried out with a Thermo Scientific iCAP 6000 series ICP-OES instrument under operating conditions listed in following table.

Thermo Scientific iCAP 6000 series operating conditions Table 5.2-1

Analysis preferences			**Source Settings**		
Sample options	Repeats	3	Nebulisher Pump	Flush Pump Rate	100 rpm
	Delay Time	0.0 sec		Analysis Pump Rate	50 rpm
	Sample Flush Time	30 sec			
Source	Sample Introduction	Nebuliser		Pump Relaxation Time	5 sec
	Plasma View	Line Selection		RF Power	1200 W
Analysis maximum	Low WL Range	Axial 15; Radial 15		Nebulisher Flow	0.65 L/min
Integration Times (sec)	High WL Range	Axial 5; Radial 5		Auxiliary Gas	1.5 L/min
Calibration Mode	Concentration				
Trailing Full Frame Options	Intelli-Frame	Yes			
	Max Integration Time	30 sec			
	WL Range	Low			
	View	Radial			

5.3 Hg – Analysis by AMA

The analysis of Hg was carried out with an Advanced Mercury Analyser (AMA 254) equipped with an autosampler for analysis of liquid samples. 100 µl of prepared extract will be applied for analysis. Time conditions were set as follows: Drying – 130 s, decomposition – 150 s, waiting – 45 s. AMA is a very specific analytical instrument used only for analysis of Hg. For settings of AMA, it is necessary to do own optimization of instrument in our conditions. Due to this fact, other specific settings are not listed.

5.4 Documentation

Documentation included in particular:

- Documentation of holes (protocol)

  Doing so the location was documented with a sketch of the site, photo documentation and GPS position was measured for each of the hole done.
- Record of sample collection (protocol)
- Identification of samples
- Record of delivery of samples to the laboratory (protocol)

Collected samples were provided with a label. Labels had the following data:

- The title and number of the contract;
- The designation of the sampled object or location;
- The required chemical analysis of the contaminant or the group of contaminants;
- The customer (the client of the contract);
- The responsible investigator and the number of the contract;
- The date of sample collection; and
- The name of the person who collected the sample.

Documentation records on primary geological documentation are deposited in the archives of the company GEOtest, a.s.

The position of the holes was tentatively surveyed in the coordinate system WGS 84 using the device Garmin eTrex Venture Cx. The results of measurement are given in Table 2.4-1.

The documentation of holes is given in Textual Annex 2.1.

5.5 Transport, Storage and Delivery of Samples to Laboratory

After their collection, the samples were placed in an ice box and transported to a temporary gathering place with a temperature of around 10°C. They were transported to accredited hydrochemical laboratories of GEOtest, a.s. after 9 days at the latest.

6. Results

The results of chemical analyses are presented in the Table 6-2.

The results of chemical analyses were compared with the values given in the following documents:

1. Low POPs level of Stockholm Convention related documents (Updated general technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (POPs), http://archive.basel.int/meetings/sbc/workdoc/techdocs.html)
2. Human health risk limit for workers on site based on CSOIL2000 calculations (Site Assessment and Feasibility Study of the Nubarashen Burial Site of Obsolete and Banned Pesticides in Nubarashen, Armenia, Phase 1 and 2 investigation report, Tauw, 2013)
3. Guidelines of MoE: Contamination indicators, Ministry of the Environment of the Czech Republic, 2011

Ad 1)

The Basel Convention (BC) has developed Technical guidelines on the Environmentally Sound Management of POPs wastes. Parties to the Stockholm Convention are invited to take these guidelines into account when implementing their obligations under Article 6 of the Convention. Updated general technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with POPs are given in Chapter III A: the following provisional definitions for low POP content should be applied:

- PCBs: 50 mg/kg (*Determined according to national or international methods and standards)*;
- PCDDs and PCDFs: 15 μg TEQ/kg (*TEQ as referred to in annex C, part IV, paragraph 2, of the Stockholm Convention, but only for PCDDs and PCDFs)*;
- Aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, HCB, mirex and toxaphene: 50 mg/kg for each (*Determined according to national or international methods and standards)*.

According to SC wastes consisting of, containing or contaminated with POPs above the low POP content should, in accordance with article 6, paragraph 1 (d) (ii) SC, be disposed of in such a way that the POP content is destroyed or irreversibly transformed or otherwise disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option.

The value 50 mg/kg d.m. is determined on the basis of consultation with the Client as the basic reference level (BRL), with which the results of chemical analyses of OCP will be compared and on the basis of which an estimate of the amount of material to be remediated will be carried out. **The BRL is determined for the sum of 2,4'-DDD+2,4'-DDE+2,4'-DDT+4,4'-DDD+4,4'-DDE+4,4'-DDT+αHCH+β HCH+γ HCH+δ HCH**.

Ad 2)

Within the study of Tauw: Site Assessment and Feasibility Study of the Nubarashen Burial Site of Obsolete and Banned Pesticides in Nubarashen, Armenia, Phase 1 and 2 investigation report, an evaluation of health risks was made for man on the basis of the results of survey work. For workers on the site (fenced area including buffer zone), CSOIL2000 calculated a human health risk limit of about 1,500 mg/kg for DDT (Tauw, 2013). The exceeding of this value:

1. identifies the areas in which it is necessary to follow stricter OHS measures; and
2. defines heavily contaminated material from medium-contaminated one.

Ad 3)

Results of chemical analyses of soil samples were also compared to criteria values fixed in Methodological Guideline of the Ministry of Environment of the Czech Republic (MG ME CR): Indicators of Contamination, March 2011. The guideline is based on US EPA values valid for June 2011. This guideline determines indicators of contamination, which represent specific concentrations of individual chemical substances in soil, soil air or groundwater.

The indicators of soil contamination correspond with the screening values of soil contamination and are determined:

- for areas used industrially (comprising areas for production and technical infrastructure);
- for the other areas apart from areas used industrially (e.g. areas for housing, areas of public amenities, mixed areas, etc.); and
- for the case of a threat to the quality of groundwater used as drinking or service water, namely by washing out contamination from soil.

Exceeding indicator values points to the indication of contamination, which should be investigated and evaluated, particularly in the light of risks for recipients of contamination and endangered ecosystems. Indicators are not remedial limits and cannot be used as remedial limits. Table 6-1 shows the values of indicators of contamination for monitored parameters.

Values of selected indicators of soil contamination Table No. 6-1

Substance	Soil		
	Areas used industrially	Other areas	Threat to groundwater quality
	mg/kg d.m.		
α HCH	0.27	0.077	0.000062
β HCH	0.96	0.27	0.00022
γ HCH	2.1	0.52	0.00036
DDD	7.2	2	0.066
DDE	5.1	1.4	0.047
DDT	7	1.7	0.067
As	1.6	0.39	0.0013
Hg	43	10	0.033

The following table shows a comparison of the results of chemical analyses with the indicators for “the other areas” with respect to the pattern of land use – the recreational area.

The table also displays data on contamination from the depth levels of the holes, at which wastes containing >95% of pure pesticides were encountered. These wastes have not been analysed.

The results of analyses were also processed graphically and are presented in Annexes 1.2 to 1.6, in which the results of analyses are depicted in depth intervals 0–0.5, 0.5–1, 1–1.5, 1.5–2, 2–2.5. Redrafting of the individual holes in color corresponds with:

- the intensity of DDT contamination: violet >1,500 mg/kg,
- the intensity of ∑OCP contamination: red 50–1,500 mg/kg and yellow <50 mg/kg of ∑OCP.

Results of chemical analyses of soil samples

Table 6-2

Object	Parameter	α HCH	β HCH	γ HCH	Δ HCH	2,4'-DDD	4,4'-DDD	∑DDD	2,4'-DDE	4,4'-DDE	∑DDE	2,4'-DDT	4,4'-DDT	∑DDT	As	Hg	∑HCH	∑xDDy	∑HCH + ∑xDDy
	Depth	ppm																	
HHR limit		-	-	-	-	-	-	-	-	-	-	-	-	1500	-	-	-	-	-
SC low POPs level/BRL		-	-	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-
Indicators of pollution (CR)		0.077	0.27	0.52	-	-	-	2	-	-	1.4	-	-	1.7	0.39	10	-	-	-
A	0–0.5	0.427	0.138	0.087	0.034	2.34	19.3	21.6	6.74	12.7	19.4	93.3	208	301.3	<5	<0.2	0.686	342.38	343.066
A	0.5–1	26.8	2.48	11.1	3.49	4.81	27.6	32.4	0.748	3.22	4.0	84.5	179	263.5	5.54	1.24	43.87	299.878	343.748
A	1–1.5	6.59	0.762	1.22	0.363	2.59	14.5	17.1	10.5	13.9	24.4	69.6	132	201.6	<5	<0.2	8.935	243.09	252.025
A	1.5–1.8	17.38	1.554	6.851	2.587	17.67	49.56	67.2	6.462	22.54	29.0	118	207.3	325.3	7.35	0.9	28.372	421.532	449.904
B	0–0.5	0.503	0.085	0.178	0.041	0.154	0.432	0.6	0.293	2.84	3.1	4.13	25.9	30.0	<5	<0.2	0.807	33.749	34.556
B	0.5–1	35.6	6.07	26.2	9.51	12.6	29.2	41.8	0.399	2.52	2.9	85.3	133	218.3	5.18	0.26	77.38	263.019	340.399
B	1–1.5	35.7	6.88	24.2	10.4	13.8	31.7	45.5	0.891	5.46	6.4	87.9	143	230.9	9.16	0.52	77.18	282.751	359.931
B	1.5–2	Not analysed, >95% pure pesticide																	
B	2–2.5	27.5	2.89	7.68	2.7	4.62	17.7	22.3	0.88	4.04	4.9	87.1	141	228.1	<5	0.51	40.77	255.34	296.110
C	0–0.5	0.036	0.009	0.012	0.002	0.019	0.049	0.1	0.042	0.317	0.4	0.281	2.04	2.3	<5	<0.2	0.059	2.748	2.807
C	0.5–1	37.94	7.19	27.02	8.445	14.42	64.67	79.1	0.6894	4.37	5.1	109.6	187.2	296.8	8.18	0.64	80.595	380.95	461.544
C	1–1.5	Not analysed, >95% pure pesticide																	
C	1.5–2	>100	>50	>100	>50	>200	>200	>400.0	>200	>200	>400.0	>1000	>1000	>2000.0	28.2	6.60	>300.0	>2800.0	>3100.0
D	0–0.5	0.019	0.003	0.005	<0.001	0.005	0.015	0.0	0.005	0.109	0.1	0.061	0.267	0.3	5.08	<0.2	0.027	0.462	0.489
D	0.5–1	13.6	0.816	2.59	0.716	0.714	3.43	4.1	0.076	0.663	0.7	34.9	131	165.9	<5	<0.2	17.722	170.783	188.505
D	1–1.5	0.225	0.227	0.071	0.064	3.24	13.6	16.8	3.16	8.17	11.3	76.2	144	220.2	6.39	<0.2	0.587	248.37	248.957
D	1.5–2	0.04465	0.03197	0.01687	0.00815	0.07612	0.3083	0.4	0.0891	0.2534	0.3	1.977	21.71	23.7	<5	<0.2	0.10164	24.414	24.516
E	0–0.5	0.094	0.035	0.047	0.011	0.049	0.143	0.2	0.03	0.535	0.6	1.17	8.31	9.5	<5	<0.2	0.187	10.237	10.424
E	0.5–1	0.053	0.094	0.037	0.046	0.202	0.492	0.7	0.055	0.941	1.0	3.69	24.3	28.0	<5	<0.2	0.23	29.68	29.910
E	1–1.5	0.031	0.055	0.012	0.004	0.312	1.11	1.4	0.125	1.66	1.8	12.7	72.2	84.9	<5	<0.2	0.102	88.107	88.209
E	1.5–2.1	0.1358	0.05806	0.01489	0.00902	0.03398	0.1444	0.2	0.1483	1.378	1.5	1.215	7.298	8.5	<5	<0.2	0.21777	10.21768	10.435
I-1	0.5–1	0.02	0.005	0.007	0.002	0.011	0.029	0.0	0.028	0.397	0.4	0.164	0.868	1.0	6.31	<0.2	0.034	1.497	1.531

Object	Parameter	α HCH	β HCH	γ HCH	Δ HCH	2,4'-DDD	4,4'-DDD	∑DDD	2,4'-DDE	4,4'-DDE	∑DDE	2,4'-DDT	4,4'-DDT	∑DDT	As	Hg	∑HCH	∑xDDy	∑HCH + ∑xDDy
	Depth	ppm																	
HHR limit		-	-	-	-	-	-	-	-	-	-	-	-	1500	-	-	-	-	-
SC low POPs level/BRL		-	-	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-
Indicators of pollution (CR)		0.077	0.27	0.52	-	-	-	2	-	-	1.4	-	-	1.7	0.39	10	-	-	-
I-2	0.5–1	0.033	0.001	0.015	0.001	0.005	0.018	0.0	0.008	0.106	0.1	0.072	0.452	0.5	5.61	<0.2	0.05	0.661	0.711
I-3	0.5–1	0.1378	0.00455	0.07004	0.00992	0.00276	0.01366	0.0	0.01184	0.08394	0.1	0.01941	0.07625	0.1	9.74	<0.2	0.22231	0.20786	0.430
I-4	0.5–1	0.014	0.013	0.002	0.001	0.01	0.011	0.0	0.019	0.405	0.4	0.113	0.269	0.4	5.56	<0.2	0.03	0.827	0.857
II-1	0–0.5	1.18	0.132	0.278	0.09	0.064	0.173	0.2	0.01	0.04	0.1	1.16	5.12	6.3	5.19	<0.2	24838.000	6.567	8.247
II-1	0.5–1	0.149	0.011	0.031	0.005	0.003	0.01	0.0	<0.002	0.006	0.0	0.035	0.192	0.2	<5	<0.2	0.196	0.246	0.442
II-2	0–0.5	0.13	0.017	0.029	0.009	0.013	0.055	0.1	0.037	1.65	1.7	0.256	0.956	1.2	5.16	<0.2	0.185	2.967	3.152
II-2	0.5–1	0.055	0.005	0.031	0.004	0.003	0.007	0.0	0.002	0.044	0.0	0.031	0.101	0.1	<5	<0.2	0.095	0.188	0.283
II-3	0.5–1	0.105	0.011	0.026	0.005	0.013	0.05	0.1	0.007	0.126	0.1	0.121	0.464	0.6	6.46	<0.2	0.147	0.781	0.928
II-4	0.5–0.8	0.015	0.004	0.006	0.002	0.005	0.014	0.0	0.009	0.074	0.1	0.063	0.329	0.4	<5	<0.2	0.027	0.494	0.521
III-1	0.5–1	0.014	<0.001	0.003	<0.001	<0.002	0.002	0.0	<0.002	0.008	0.0	0.007	0.03	0.0	5.22	<0.2	0.017	0.047	0.064
III-2	0–0.5	0.269	0.855	0.108	0.487	27.4	69.3	96.7	2.83	15.4	18.2	119	210	329.0	5.17	0.2	1.719	443.93	445.649
III-2	0.5–0.8	0.06322	0.06942	0.02791	0.06442	1.099	3.905	5.0	0.08372	0.4666	0.6	46.54	146.9	193.4	<5	<0.2	0.22497	198.99432	199.219
III-3	0–0.5	0.158	0.797	0.069	0.068	3.5	19.3	22.8	0.284	2.85	3.1	93.4	186	279.4	<5	0.57	1.092	305.334	306.426
III-3	0.5–1	45.5	30.2	14.6	8.62	21.7	69.4	91.1	1.74	9.94	11.7	115	213	328.0	5.02	1.18	98.92	430.78	529.700
III-3	1–1.5	0.093	0.093	0.098	0.173	0.096	0.318	0.4	0.016	0.149	0.2	4.27	21.3	25.6	<5	<0.2	0.457	26.149	26.606
III-4	0.5–1	0.062	0.007	0.024	0.006	0.011	0.032	0.0	0.007	0.037	0.0	0.127	0.698	0.8	5.74	<0.2	0.099	0.912	1.011
III-5	0.5–1	0.058	0.006	0.031	0.004	0.01	0.027	0.0	0.027	0.111	0.1	0.143	1.021	1.2	6.26	<0.2	0.099	1.339	1.438
IV-1	0.5–1	0.031	0.003	0.006	0.001	0.003	0.007	0.0	0.005	0.081	0.1	0.031	0.129	0.2	5.3	<0.2	0.041	0.256	0.297
IV-1	1–1.4	0.122	0.006	0.021	0.004	0.006	0.022	0.0	0.013	0.054	0.1	0.071	0.287	0.4	6.91	<0.2	0.153	0.453	0.606
IV-2	0.5–1	0.093	0.022	0.048	0.006	0.021	0.089	0.1	0.021	0.224	0.2	0.584	4.5	5.1	<5	<0.2	0.169	5.439	5.608
IV-2	1–1.4	0.022	0.008	0.01	<0.001	0.003	0.007	0.0	0.009	0.091	0.1	0.053	0.22	0.3	5.96	<0.2	0.04	0.383	0.423
IV-3	0.5–1	50.1	23.5	33.5	10.5	40	89.9	129.9	17.9	55.7	73.6	115	211	326.0	13	0.54	117.6	529.5	647.100
IV-3	1–1.3	69.6	16	14.1	4.77	12.7	51.9	64.6	1.39	5.57	7.0	264	332	596.0	6.31	0.73	104.47	667.56	772.030
IV-4	0.5–1	11.2	1.05	3.42	0.62	1.85	7.66	9.5	1.36	6.908	8.3	62.7	111	173.7	7.34	0.43	16.29	191.478	207.768

Object	Parameter	α HCH	β HCH	γ HCH	Δ HCH	2,4'-DDD	4,4'-DDD	∑DDD	2,4'-DDE	4,4'-DDE	∑DDE	2,4'-DDT	4,4'-DDT	∑DDT	As	Hg	∑HCH	∑xDDy	∑HCH + ∑xDDy
	Depth	ppm																	
HHR limit		-	-	-	-	-	-	-	-	-	-	-	-	**1500**	-	-	-	-	-
SC low POPs level/BRL		-	-	-	-	-	-	-	-	-	-	-	-	**50**	-	-	-	-	-
Indicators of pollution (CR)		**0.077**	**0.27**	**0.52**	-	-	-	**2**	-	-	**1.4**	-	-	**1.7**	**0.39**	**10**	-	-	-
IV-4	1–1.5	2.65	0.315	0.482	0.147	0.669	4.9	5.6	0.088	0.469	0.6	44.4	109	153.4	5.78	<0.2	3.594	159.526	163.120
IV-5	0.5–1	18	1.61	2.09	0.913	2.18	7.92	10.1	5.73	12.9	18.6	73.6	162	235.6	6.9	0.5	22.613	264.33	286.943
IV-5	1–1.4	1.72	0.207	0.212	0.072	0.061	0.27	0.3	0.034	0.133	0.2	1.68	8.79	10.5	5.7	<0.2	2.211	10.968	13.179
V-1	0.5–1	11.5	6.17	0.102	0.371	29.8	89.3	119.1	10.1	31.1	41.2	117	200	317.0	8.21	<0.2	18.143	477.3	495.443
V-1	1–1.5	1.45	0.25	1.08	0.304	0.875	3.33	4.2	1.24	8.57	9.8	22.4	95.4	117.8	5.87	<0.2	3.084	131.815	134.899
V-2	0.5–1	30.8	4.29	14.9	3.61	85.7	94.7	180.4	13.1	38.4	51.5	145	173	318.0	8.78	<0.2	53.6	549.9	603.500
V-2	1–1.5	0.394	0.099	0.102	0.033	1.51	3.96	5.5	3.66	8.18	11.8	45.7	148	193.7	5.43	<0.2	0.628	211.01	211.638
V-3	0.5–1	21.4	1.93	12.6	3.012	50.6	118	168.6	126	170	296.0	305	415	720.0	6.77	0.59	38.942	1184.6	1223.542
V-3	1–1.3	10.9	1.16	3.44	1.16	46	99.4	145.4	72.9	68.6	141.5	102	180	282.0	7.3	<0.2	16.66	568.9	585.560
V-4	0.5–1	0.03	0.01	0.016	0.002	0.067	0.079	0.1	0.243	3.85	4.1	0.759	5.01	5.8	6.43	<0.2	0.058	10.008	10.066
V-4	1–1.5	0.024	0.005	0.008	0.001	0.021	0.06	0.1	0.037	0.357	0.4	0.522	4.08	4.6	6.52	<0.2	0.038	5.077	5.115
V-5	0.5–1	36.66	4.671	37.36	4.872	83.72	152.6	236.3	6.917	23.77	30.7	131	204.7	335.7	84.7	13.2	83.563	602.707	686.270
V-5	1–1.5	10.9	1.06	0.019	11	19.2	52.9	72.1	1.94	11.2	13.1	93.2	190	283.2	96.3	4.2	22.979	368.44	391.419
V-6	0.5–1	46.5	18.7	35	20.2	98.1	104	202.1	13.6	49.7	63.3	133	190	323.0	24.1	10.2	120.4	588.4	708.800
V-6	1–1.3	Not analysed, >95% pure pesticide																	
V-6	1.3–1.5	2.22	0.306	1.05	0.256	0.833	5.21	6.0	0.766	3.64	4.4	45.2	141	186.2	<5	<0.2	3.832	196.649	200.481
V-7	0.5–1	3.98	0.545	0.857	0.06	0.592	2.77	3.4	0.443	1.161	1.6	30.6	126	156.6	5.88	<0.2	5.442	161.566	167.008
V-7	1–1.4	0.311	0.124	0.199	0.028	0.066	0.284	0.4	0.149	0.388	0.5	1.68	9.63	11.3	5.27	<0.2	0.662	12.197	12.859
VI-1	0.5–1	0.011	<0.001	0.005	0.001	0.008	0.023	0.0	0.005	0.05	0.1	0.183	0.87	1.1	5.21	0.28	0.017	1.139	1.156
VI-1	1–1.5	0.015	0.003	0.008	0.003	0.009	0.029	0.0	0.015	0.125	0.1	0.127	0.622	0.7	5.8	<0.2	0.029	0.927	0.956
VI-2	0.5–1	0.014	0.001	0.011	0.001	0.013	0.011	0.0	0.055	0.766	0.8	0.207	0.438	0.6	<5	<0.2	0.027		1.517
VI-2	1–1.5	0.021	0.001	0.015	0.003	0.005	0.015	0.0	<0.002	0.008	0.0	0.111	0.514	0.6	<5	<0.2	0.04	0.653	0.693
VI-3	0.5–1	32.8	6.65	22.7	7.58	27.6	68.8	96.4	1.69	11.3	13.0	105	147	252.0	5.28	0.42	69.73	361.39	431.120
VI-3	1–1.5	0.531	0.045	0.091	0.056	0.029	0.111	0.1	0.008	0.062	0.1	0.747	6.06	6.8	<5	<0.2	0.723	7.017	7.740

Object	Parameter	α HCH	β HCH	γ HCH	Δ HCH	2,4'-DDD	4,4'-DDD	∑DDD	2,4'-DDE	4,4'-DDE	∑DDE	2,4'-DDT	4,4'-DDT	∑DDT	As	Hg	∑HCH	∑xDDy	∑HCH + ∑xDDy
	Depth	ppm																	
HHR limit		-	-	-	-	-	-	-	-	-	-	-	-	1500	-	-	-	-	-
SC low POPs level/BRL		-	-	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-
Indicators of pollution (CR)		0.077	0.27	0.52	-	-	-	2	-	-	1.4	-	-	1.7	0.39	10	-	-	-
VI-4	0.5–1	4.49	1.52	0.004	0.089	0.921	4.04	5.0	0.108	1.1	1.2	43.6	117	160.6	<5	<0.2	6.103	166.769	172.872
VI-4	1–1.5	0.106	0.037	0.033	0.028	0.065	0.193	0.3	0.042	0.614	0.7	1.512	6.95	8.5	5.57	<0.2	0.204	9.376	9.580
VI-5	0–0.5	30.4	3.6	11.8	4.82	16.8	49.7	66.5	1.85	9.06	10.9	91.9	177	268.9	5.15	0.32	50.62	346.31	396.930
VI-5	0.5–1	>100	>50	>100	>50	>200	>200	>400.0	>200	>200	>400.0	>1000	>1000	>2000.0	11.40	4.12	>300.0	>2800.0	>3100.0
VI-5	1–1.3	12.5	0.953	2.63	0.93	4.13	15	19.1	0.22	1.38	1.6	86.9	172	258.9	5.28	0.25	17.013	279.63	296.643
VI-6	0.5–1	51.1	22.9	36.9	33.1	29.4	84.9	114.3	3.78	13.4	17.2	107	200	307.0	13.8	6.16	144.0	438.48	582.480
VI-6	1–1.4	46.5	23.4	52.7	39.4	75.8	78.3	154.1	9.2	26	35.2	118	140	258.0	15	9.4	162.0	447.3	609.3
VII-1	0.5–1	29.7	4.28	3.69	2.3	2.83	15.7	18.5	0.751	5.84	6.6	78.8	158	236.8	6.41	<0.2	39.97	261.921	301.891
VII-1	1–1.5	0.127	0.029	0.052	0.026	0.025	0.07	0.1	0.015	0.087	0.1	0.464	4.07	4.5	<5	<0.2	0.234	4.731	4.965
VII-2	0.5–1	44.7	28.3	32.6	21.9	13.2	47.4	60.6	1.16	5.51	6.7	104	188	292.0	7.15	0.3	127.5	359.27	486.770
VII-2	1–1.5	4.01	0.483	2.24	0.774	0.464	1.42	1.9	0.244	0.433	0.7	16.8	67.9	84.7	6.97	0.57	7.507	87.261	94.768
VII-2	1.5–2	4.36	0.664	2.11	1.17	0.213	0.896	1.1	0.063	0.162	0.2	9.94	44.8	54.7	10.1	0.2	8.304	56.074	64.378
VII-3	0.5–1	0.168	0.026	0.09	0.036	0.021	0.051	0.1	0.054	0.578	0.6	0.269	0.694	1.0	7.75	<0.2	0.32	1.667	1.987
VII-3	1–1.5	0.099	0.034	0.045	0.023	0.359	7.62	8.0	0.857	2.74	3.6	71.9	1.86	73.8	7.57	<0.2	0.201	85.336	85.537
VII-4	0.5–1	0.189	0.017	0.171	0.029	0.03	0.062	0.1	0.069	0.899	1.0	0.703	2.51	3.2	5.46	<0.2	0.406	4.273	4.679
VII-4	1–1.5	0.056	0.047	0.028	0.005	0.087	0.217	0.3	0.295	4.23	4.5	3.73	27.5	31.2	5.28	<0.2	0.136	36.059	36.195
VII-5	0.5–1	12.9	1.73	0.997	1.29	2.96	9.81	12.8	7.86	9.18	17.0	68.79	115	183.8	5.34	0.25	16.917	213.6	230.517
VII-5	1–1.4	1.436	0.5979	0.4131	1.133	2.581	8.674	11.3	5.901	8.123	14.0	59.05	147.4	206.5	6.72	0.2	3.580	231.729	235.309
VII-6	0.5–1	0.249	0.231	0.128	0.084	0.561	0.914	1.5	2.04	14.8	16.8	22	81.7	103.7	5.6	<0.2	0.692	122.015	122.707
VII-6	1–1.5	0.195	0.2	0.097	0.065	0.056	0.198	0.3	0.036	0.182	0.2	1.24	6.44	7.7	10.1	0.9	0.557	8.152	8.709
VIII-1	0.5–1	0.314	0.005	0.16	0.017	0.006	0.012	0.0	0.006	0.113	0.1	0.048	0.166	0.2	<5	<0.2	0.496	0.351	0.847
VIII-2	0.5–0.8	0.016	0.003	0.006	<0.001	0.071	0.04	0.1	1.45	19.3	20.8	1.37	17.8	19.2	5.61	<0.2	0.025	40.031	40.056
VIII-3	0.5–1	0.041	0.007	0.014	0.007	0.004	0.012	0.0	0.015	0.482	0.5	0.052	0.263	0.3	7.04	<0.2	0.069	0.828	0.897
VIII-4	0.5–1	0.022	0.019	0.011	0.002	0.054	0.145	0.2	0.046	0.531	0.6	0.987	12.2	13.2	5.25	<0.2	0.054	13.963	14.017

Object	Parameter	α HCH	β HCH	γ HCH	Δ HCH	2,4'-DDD	4,4'-DDD	∑DDD	2,4'-DDE	4,4'-DDE	∑DDE	2,4'-DDT	4,4'-DDT	∑DDT	As	Hg	∑HCH	∑xDDy	∑HCH + ∑xDDy
	Depth	ppm																	
HHR limit		-	-	-	-	-	-	-	-	-	-	-	-	1500	-	-	-	-	-
SC low POPs level/BRL		-	-	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-
Indicators of pollution (CR)		0.077	0.27	0.52	-	-	-	2	-	-	1.4	-	-	1.7	0.39	10	-	-	-
VIII-5	0.5–1	0.056	0.015	0.024	0.009	0.005	0.014	0.0	<0.002	0.008	0.0	0.049	0.274	0.3	<5	<0.2	0.104	0.35	0.454
IX-1	0.5–1	0.048	0.033	0.023	0.002	0.668	0.627	1.3	1.76	38.4	40.2	4.81	21.9	26.7	7.27	<0.2	0.106	68.165	68.271
IX-2	0.5–1	0.017	0.008	0.007	0.002	0.074	0.034	0.1	0.57	11.7	12.3	1.218	11.7	12.9	6.52	<0.2	0.034	25.296	25.330
X-1	0–0.5	0.04065	0.00123	0.01498	0.00159	<0.002	0.00232	0.0	<0.002	0.01195	0.0	0.00644	0.02492	0.0	<5	<0.2	0.05845	0.04563	0.104
X-2	0–0.5	0.038	0.004	0.026	0.004	0.004	0.02	0.0	0.003	0.015	0.0	0.037	0.159	0.2	<5	<0.2	0.072	0.238	0.310
X-3	0–0.5	0.019	0.077	0.014	0.008	0.079	0.314	0.4	0.814	2.39	3.2	0.947	11.7	12.6	<5	<0.2	0.118	16.244	16.362
X-4	0–0.5	0.2038	0.00134	0.05407	0.00372	0.00207	0.00657	0.0	0.0035	0.02024	0.0	0.01797	0.06411	0.1	<5	<0.2	0.26293	0.11446	0.377
X-4	0.5–1	0.1272	0.00152	0.04143	0.00267	0.00239	0.00524	0.0	0.00426	0.04631	0.1	0.02246	0.07019	0.1	5.46	<0.2	0.17282	0.15085	0.324
X-5	0–0.5	0.274	0.013	0.226	0.041	0.054	0.038	0.1	0.195	7.16	7.4	1.64	3.54	5.2	7.34	<0.2	0.554	12.627	13.181
X-5	0.5–1	0.155	0.008	0.059	0.008	0.012	0.011	0.0	0.05	1.07	1.1	0.312	0.527	0.8	6.33	<0.2	0.23	1.982	2.212

***Explanatory notes**: ∑**xDDy** = 2.4'-DDD+2.4'-DDE+2.4'-DDT+4.4'-DDD+4.4'-DDE+4.4'-DDT. ∑**xHCH**= α HCH+β HCH+γ HCH+δ HCH*

7. Evaluation of Results

The basis for the general determination of the amount of above-limit contaminated material was the results of chemical analyses carried out by the company GEOtest, a.s. in November 2013, depicted in the maps of soil contamination by POPs at the individual depth levels measured from the ground surface. The approximate areal delineation of above-limit contaminated material was interpolated and, where data are insufficient, the boundary was extrapolated. 50 mg of OCP/kg d.m was determined as the reference concentration for ∑4,4'-DDT+2,4'-DDT+4,4'-DDD+2,4'-DDD+4,4'-DDE+2,4'-DDE+α HCH+β HCH+γ HCH+δ HCH.

15 samples were taken from the depth interval 0–0.5 (measured from the ground surface) in compliance with the plan of sampling. Above-limit concentrations were detected in two areas: area III and on the body of the landfill in its western part. In this depth interval, the areal extent of contamination can be estimated at 300 m^2 Ч 0.5 m = 150 m^3 only in the sampled area.

The depth interval 0.5–1 m was sampled most often. At this depth level, above-limit contamination was identified in the landfill body (clay partitions) and in the adjacent areas III, IV, V, VI and VII. An isolated occurrence was detected between trenches (IX-1). The areal extent of above-limit contaminated material in the depth interval 0.5–1 m can generally be determined at 3,000 m^2 Ч 0.5 m = 1,500 m^3.

In the depth interval 1–1.5, above-limit contamination was identified on a surface area of 2,800 m^2 Ч 0.5 = 1,400 m^3. This material occurred particularly in the landfill body and in its close vicinity in the areas IV to VII. In holes C and V-6, occurrences of > 95% of pure pesticides were detected.

Samples from the depth interval 1.5-2 were collected only in the holes installed into the landfill body (A, B, C, D and E) – into the places in which earth partitions separating individual cells with OCP were assumed. Above-limit concentrations were identified in holes A, B and C. In hole C, the concentration exceeded 1,500 mg/kg – the Human Health Risk limit (Tauw, 2013). In hole B, an occurrence of > 95% of pure pesticides was encountered.

The depth interval 2–2.5 m is represented by one sample from hole B, in which the concentration of OCP has exceeded the limit value.

The analyses of soil samples taken outside the fenced area have shown that OCPs occur in the upper near-surface layer at low concentrations; increased concentrations have been detected at the gate to the premises. It is probable that the contamination can be spread due to the increased movement in the area around the gate rather than due to the wind.

The results of soil analyses have proved the occurrence of As mostly at increased concentrations as compared with the indicators of contamination (MG ME CR, 2011) for “the other areas”. The highest concentration was determined in sample V-5 1-1.5 collected at the base of the landfill and it is certain that it comes from an anthropogenic source. The occurrence of As in soils relates to the pesticides deposited at the site.

The concentrations of Hg were identified in soils mostly below the detection limit of the applied method of determination (< 0.2 mg/kg d.m.). The highest concentration was detected in sample V-5 0.5–1. As in the case of As, the high concentrations of Hg relate to the pesticides deposited at the site.

8. Conclusion and Recommendations

- The 4,4'-DDT, 2,4'-DDT, 4,4'-DDD, 2,4'-DDD, 4,4'-DDE, 2,4'-DDE, α HCH, β HCH, γ HCH, δ HCH, Hg and As have been determined in soil samples in dry matter.
- The value 50 mg/kg d.m for ∑4,4'-DDT+2,4'-DDT+4,4'-DDD+2,4'-DDD+4,4'-DDE+2,4'-DDE+α HCH+β HCH+γ HCH+δ HCH (OCP) has been determined as the reference concentration for the definition of contaminated material.
- Based on the results of chemical analyses it can be noted that the occurrence of soil contamination by POPs, particularly by OCP, has been confirmed at the site.
- Above-limit soil contamination in the area between the hillock and the surface drainage has been detected to a depth of 1.5 m in most of the holes. In most cases the depth range of above-limit contamination could not be verified due to the impermeability of the geological environment for the borehole technology used.
- The areal extent of above-limit contaminated material in the depth interval 0.5–1 m inside the fenced area can be determined in general at 3,000 m^2 Ч0.5 m = 1,500 m^3.
- In the depth interval 1–1.5 inside the fenced area, above-limit contamination was detected on a surface area of 2,800 m^2 Ч0.5 = 1,400 m^3.
- The occurrence of contamination in the upper layer was also identified outside the fenced area.
- The holes installed into the partitions of the landfill body have documented the following composition of the structural layers of the landfill:

0–0.5 m	Fill (man-made layer): clayey-silty soil;
0.5 m:	2 Ч1 mm black smooth HDPE sheet;
0.5–0.6 m:	Fill: gray heavily contaminated sandy subbase;
0.6–1.5 m:	Fill: heavily contaminated soil.

- The holes made to the toe of the landfill have not detected the presence of a HDPE sheet.
- Not one of the holes has encountered the groundwater table.
- On the surface of the landfill, there are remnants of bags of pesticides, which are washed out by precipitation water.
- To estimate the total amount of above-limit contaminated material at the site, it is necessary to make a synthesis of the data given in this document with the results of previous survey work.