Nordic Environment Finance Corporation

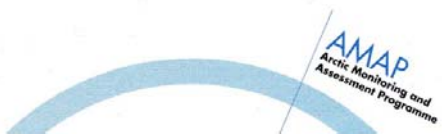
Arctic Monitoring and Assessment Program

Polar Foundation

TECHNICAL REPORT

ON THE SURVEY OF THE CURRENT STATE OF THE AREAS OF DECOMMISSIONED MILITARY BASES OF THE MINISTRY OF DEFENSE ON HOFFMAN, GRAHAM BELL AND ALEXANDRA ISLANDS OF FRANZ JOSEF LAND ARCHIPELAGO

Moscow 2008



LIST OF CONTENT

TEXT OF REPORT

1. INTRODUCTION

This report presents the results of the survey of the state of the areas of decommissioned sites of the Russian Federation Ministry of Defense **on Hoffman, Graham Bell and Alexandra Islands of Franz Josef Land Archipelago.**

Work is based on **Agreement between NPO "POLAR FOUNDATION" and Nordic Environment Finance Corporation (NEFCO).**

The survey was agreed with:

the Ministry of Defense, ref. No. 110/4/429 of 16.03.2007 signed by the First Deputy Minister of Defense Yu. Baluevsky;

Rosprirodnadzor Administration for Arkhangelsk Region, ref. w/o No. of 05.09.2007 signed by acting Head of Rosprirodnadzor Administration for Arkhangelsk Region A. Serebrennikov.

The goal of work was reconnaissance of the present state of the areas of decommissioned sites of the Russian Federation Ministry of Defense on Hoffman, Graham Bell and Alexandra Islands including assessment of man-made degradation and levels of soil contamination to determine the scope and composition of work on reclamation and remediation of the area.

The composition of monitored pollution indices was determined on the basis of requirements to the quality of soils and grounds established by the Russian regulatory documents (GOST, SanPiN (Sanitary Regulations and Standards) and directive documents, as well as recommendations of the Arctic Monitoring and Assessment Programme (AMAP) for key areas of observation of level of contamination with persistent organic pollutants (POP).

In addition, the survey included collection and analysis of technical liquid samples to detect the probable presence of unaccounted products containing polychlorinated biphenyls such as sovols, sovtols and hexanols.

Non-Profit Organization Foundation of Polar Research "POLAR FOUNDATION" is the Contractor, which carries out general administration and coordination of the survey.

LLC "I.K.M. Engineering", Saint-Petersburg and North-West Branch of SPA "Typhoon", Saint-Petersburg were involved as Subcontractors.

LLC "I.K.M. Engineering" has License No. R/2006/0049/100L of July 3 2006 issued by the Federal Service for Hydrometeorology and Environmental Monitoring for the activity in the field of hydrometeorology and the adjacent fields of activity including determination of environmental contamination level, preparation and submission of analytical and calculated information on the environmental state and environmental contamination to consumers.

The Company has a testing laboratory "Marintest" certified by the Federal Agency for Technique Regulation and Metrology within the Accreditation System for Analytical Laboratories (Centers); Accreditation Certificate No ROSS RU.0001.513066 of May 13, 2005.

SPA "Typhoon" has License R/2002/0064/100\L of 19.08.2002 for the activity in the field of hydrometeorology and the adjacent fields of activity issued by the Federal Service for Hydrometeorology and Environmental Monitoring. Also the North-West Branch of SPA "Typhoon" has a Chemical Analytical Testing Center "ARLEKS" certified by the Federal Agency for Technique Regulation and Metrology within the Accreditation System for Analytical Laboratories (Centers); Accreditation Certificate No ROSS RU.0001.510523 of 23.10.2006.

LLC "I.K.M. Engineering" performed most work on analysis of samples and specimens, compilation of schematic maps of man-made degradation elements and preparation of the report sections.

The North-West Branch of SPA "Typhoon" was involved in field work and chemical analytical study of part of soil samples.

Field work was performed during the cruise of the **Northern Hydrometeorological Service Administration's Research Vessel "Mikhail Somov"** supplying polar stations and researches within the 2007/2008 International Polar Year Program.

Field work and laboratory researches were based on applicable regulatory documents regulating the requirements to observations, sampling and analysis procedure.

Characteristics of the territory under study

Alexandra, Hoffman and Graham Bell Islands make part of Franz Josef Land Archipelago which is situated in the Western Russian Arctic, northeast of the Barents Sea and is the northernmost landmass of Eurasia. Franz Josef Land is an archipelago consisting of 196 islands of 16096 sq. m. FJL falls administratively into Arkhangelsk Region. The archipelago has no permanent inhabitants.

In the period from the early 50's to the early 90's several military and frontier sites were established. Since the early 90's, almost all of these sites have been closed except for frontier site Nagurskaya on Alexandra Island. After the sites had been closed, they were not duly mothballed and equipment and materials removed due to extremely high transportation costs. Tens of thousands of tons of oil products and lubricants in drums and tanks have been abandoned on the archipelago including waste oils and several millions of drums with fuel and lubricant residues as well as abandoned equipment and machinery, ruins of residential and processing structures. Many of them are in critical state

Figure 1 shows a schematic map of Franz Josef Land archipelago with the islands on which work was performed.

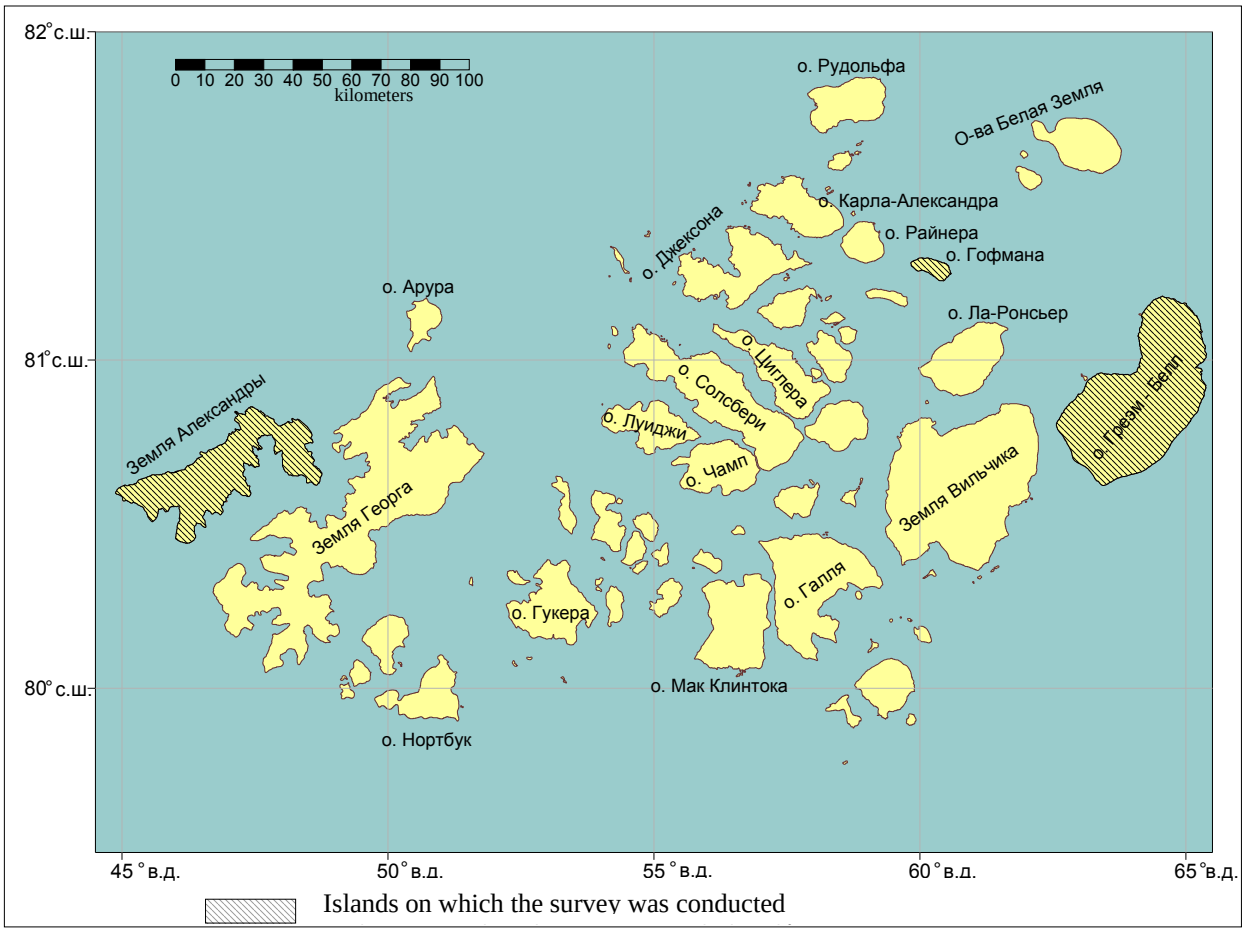


Figure 1. Schematic map of Franz Josef Land archipelago with the islands on which the survey was conducted

2. DIVISION OF WORK

2.1. Survey of the present state of man-made degradation of the territory

Air and land survey of the areas of decommissioned sites of the Russian Federation Ministry of Defense on Hoffman, Graham Bell and Alexandra Islands was made in the period from September 15 to 21, 2007. The equipment and expeditionary team was transported to FJL archipelago by Research Vessel "Mikhail Somov". The 2nd Arkhangelsk United Aviation Division's helicopter MI-8T based on the expeditionary vessel was used for air survey and transportation of the expeditionary team to the coast. Land survey and collection of soil and technical liquid samples was made at 10 sites. The charts on figures 2-1, 2-2 and 2-3 show the location of the surveyed territories of decommissioned sites of the Russian Federation Ministry of Defense and printed schematic maps with detected man-made degradation in scales 1:1000 and 1:5000. Characteristics of the areas of air and land survey are shown in Table 2.1-1.

Table 2.1-1 Characteristics of the areas of air and land survey

Area	No. of site of land survey	Surveyed territory size km^2	Description
Alexandra Island	1	0.2	Fuel and lubricant storage facility in Severnaya Bay
	9	2.9	Radar station (air defense radar post, fuel and lubricant storage facility)
	10		Fuel and lubricant storage facility, settlement of Nagurskoe
Graham Bell Island	2	8.0	Aviation camp
	3		Area of the landing strip
	4	5.6	Air defense base
	5	1.1	Drum storage facility on the coast
Hoffman Island	6	2.2	Settlement
	7	2.2	Drum storage facility on the glacier
	8	1.7	Drum storage facility on the coast
Total:	**10**	**23.9**	

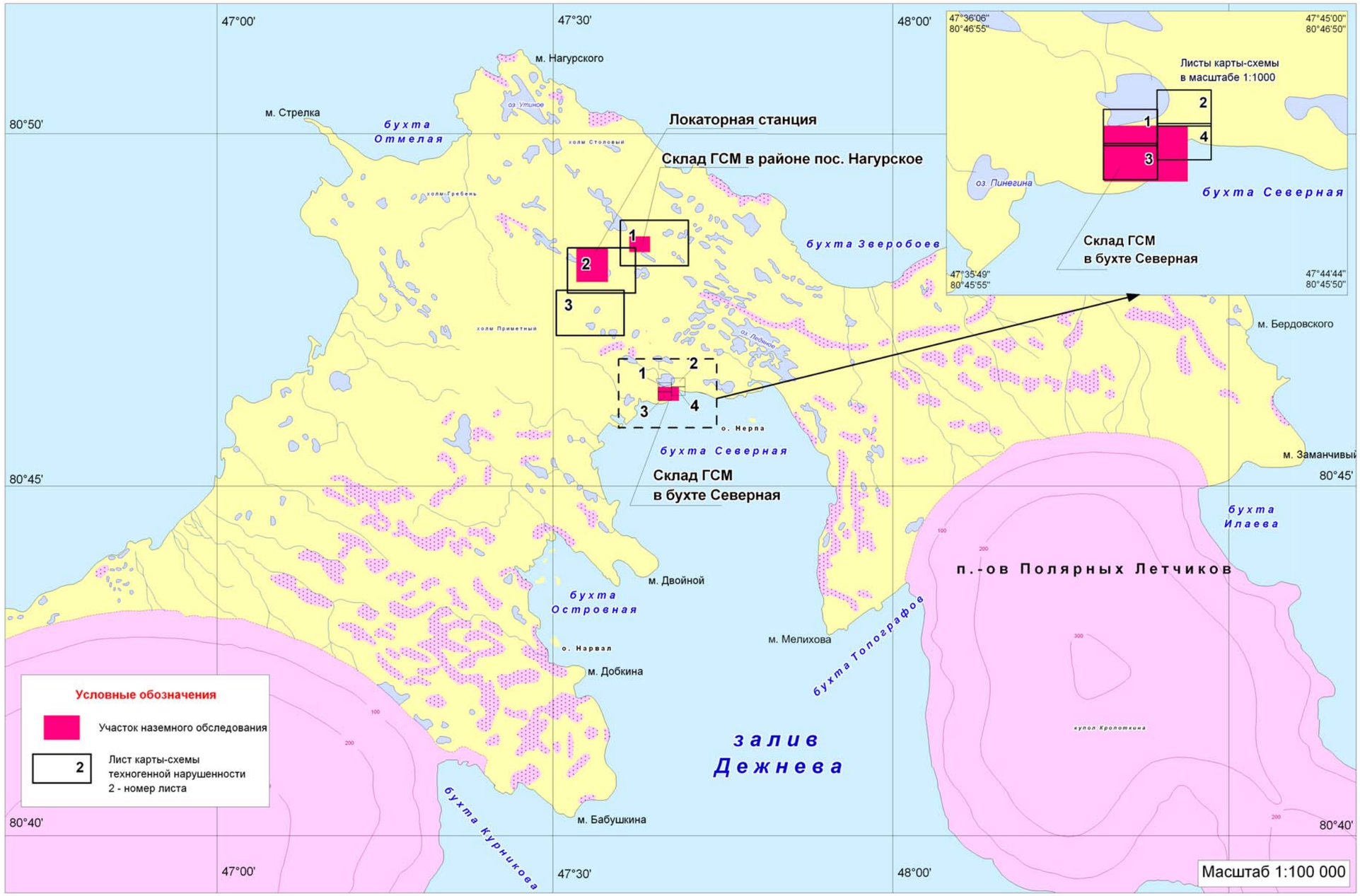


Схема расположения участков авиационного и наземного обследования на о. Земля Александры

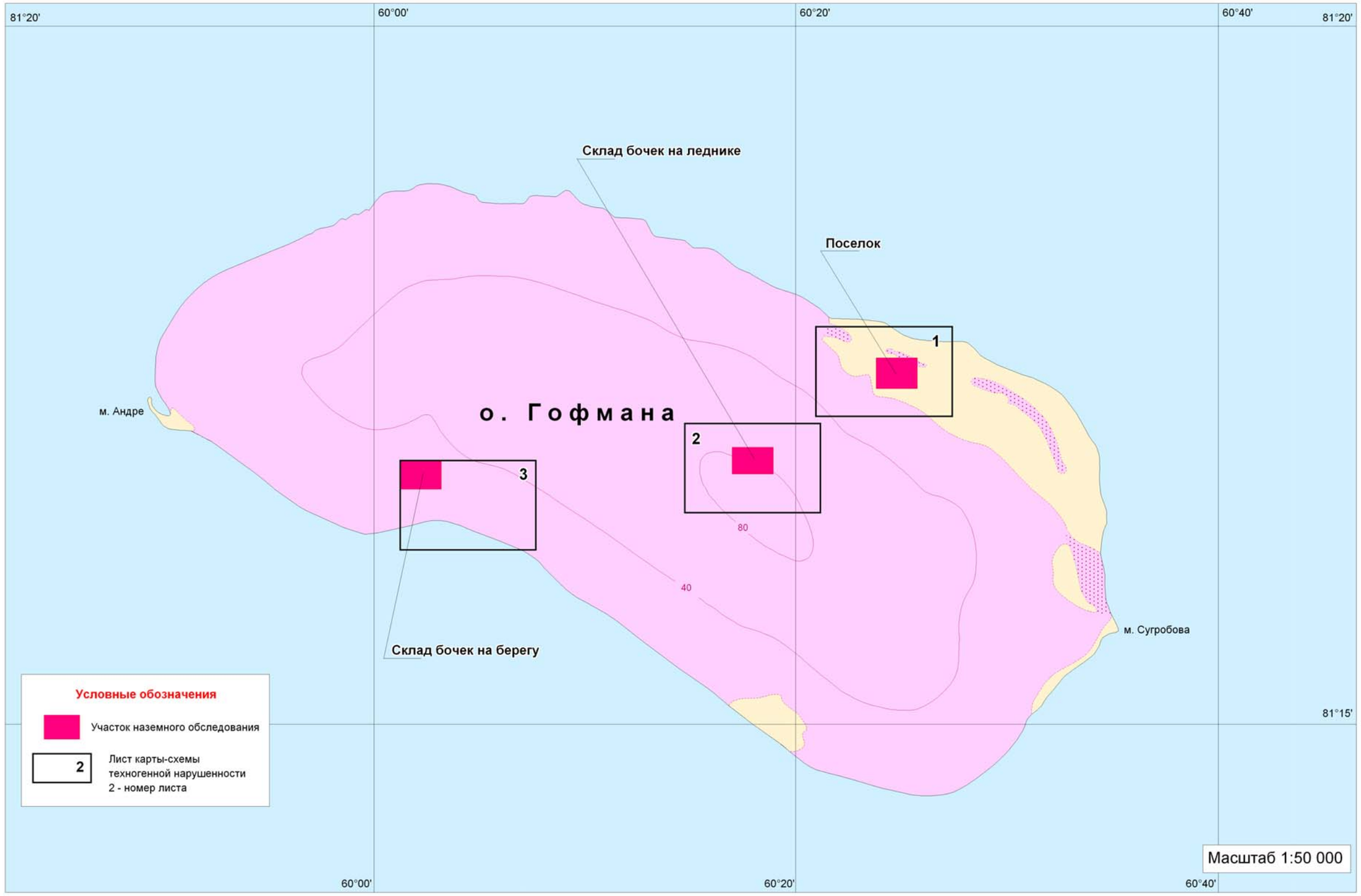


Схема расположения участков авиационного и наземного обследования на о. Гофмана

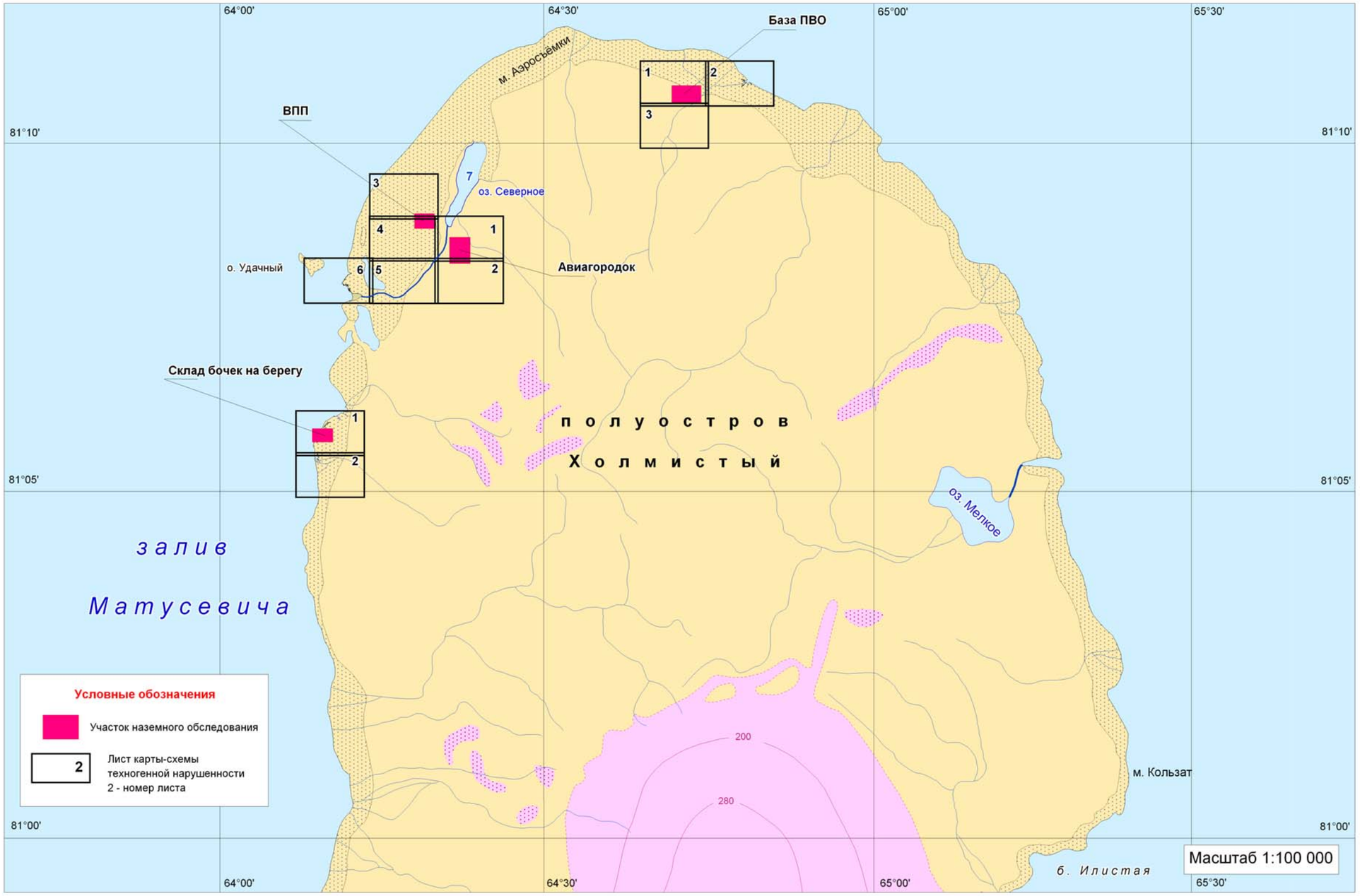


Схема расположения участков авиационного и наземного обследования на о. Греэм-Белл

2.2 Chemical and environmental survey of the area with the most evident potential pollution signs

Simultaneously with the air survey of the state of man-made degradation of the territory there were detected the areas with the most evident potential pollution signs for the subsequent collection of soil and technical liquid samples

Alexandra Island

Site 1. The site is situated on the Severnaya Bay coast near the berth on which the equipment is disembarked from water crafts. There a lot of tanks and metal drums at the area. Some tanks are now used as oil and lubricants storage facility. The drums have labels of the 50's and 80's. The drums having labels of the 50's are empty; those of the 80's are partially full of oil and lubricants

The schematic map of sites of geoecological testing is shown in Figure 2.2-12 at the end of the section.

Figure 2.2-1 Fuel and lubricant storage facility area in Severnaya Bay

Site 9. Several facilities having the name "Radar station", since the ruined radar facilities are the most typical structures. According to information from the helicopter crew, there was an air defense post there. The hydrometeorological station was situated near the post; however, no typical meteorological site was found there. There are several abandoned structures (one of them has a sign "ДЭС-2", wooden elevated road, tanks the content and degree of fullness of which could not be determined. The area is littered with waste metal structures and other wastes. There are a lot of traces of oil pollution on the thawed soil.

The schematic map of sites of geoecological testing is shown in Figure 2.2-10 at the end of the section.

Figure 2.2-2 Radar station area

Site 10. The test site of drums cleanup and pollution consequences, at which the group headed by Yu.S. Lukyanov (Polar Foundation) performed the experimental work.

The schematic map of sites of geoecological testing is shown in Figure 2.2-11 at the end of the section.

Hoffman Island

Site 6. Settlement. The typical objects are several wooden structures and drums. The drums were not opened using materials at hand. Contamination of ice with oil products was not observed.

The schematic map of sites of geoecological testing is shown in Figure 2.2-13 at the end of the section.

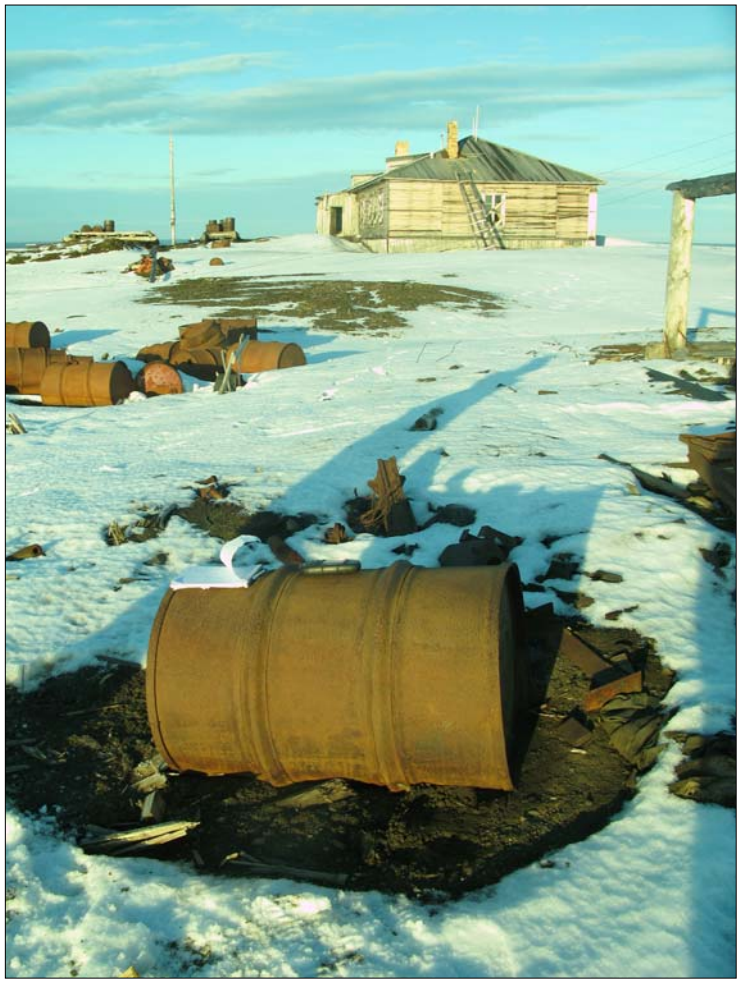


Figure 2.2-3 Settlement area

Site 7. Drum storage facility on the glacier. The typical objects are two half-ruined wooden structures, a truck and drums. The drums are covered with a thick snow layer (about 50 cm). The drums were not opened using materials at hand. Contamination of ice with oil products was not observed.

The schematic map of sites of geoecological testing is shown in Figure 2.2-14 at the end of the section.

Figure 2.2-4 Drum storage facility on the glacier area

Site 8. Drum storage facility on the glacier near the coast. There are heaps of coal near the drums. The drums were not opened using materials at hand.

The schematic map of sites of geoecological testing is shown in Figure 2.2-15 at the end of the section.

Figure 2.2-5 Drum storage facility on the coast area

Graham Bell Island

Site 2. Aviation camp (corresponds to station II in the 2004 report). The typical objects are long one-storey buildings, multiple household buildings and a damaged aircraft. There are a lot of drums at the aviation camp area (many of them are mounted horizontally in multiple rows in the open air). Most drums are filled with fuel and lubricants; some of them are marked with "poison" label (according to the helicopter crew members, the drums contain aviation fuel catalyst).

The schematic map of sites of geoecological testing is shown in Figure 2.2-16 at the end of the section.

Figure 2.2-6 Aviation camp area

Site 3. Landing strip (corresponds to station III in the 2004 report). There are tanks with fuel and lubricants, transformers, fuelling equipment and vehicles near the landing strip.

The schematic map of sites of geoecological testing is shown in Figure 2.2-17 at the end of the section.

Figure 2.2-7 Landing strip area

Site 4. Air defense base (corresponds to station I in the 2004 report). The typical objects are a two-storey storey barrack, household buildings (boiler rooms, diesel-rooms, radars, etc.). The area is littered with metal structures and construction and other wastes.

The schematic map of sites of geoecological testing is shown in Figure 2.2-18 at the end of the section.

Figure 2.2-8 Air defense base area

Site 5. Fuel and lubricant storage facility on the coast. The typical objects are big tanks, brick structure, drums. The drums were not opened using materials at hand.

The schematic map of sites of geoecological testing is shown in Figure 2.2-19 at the end of the section.

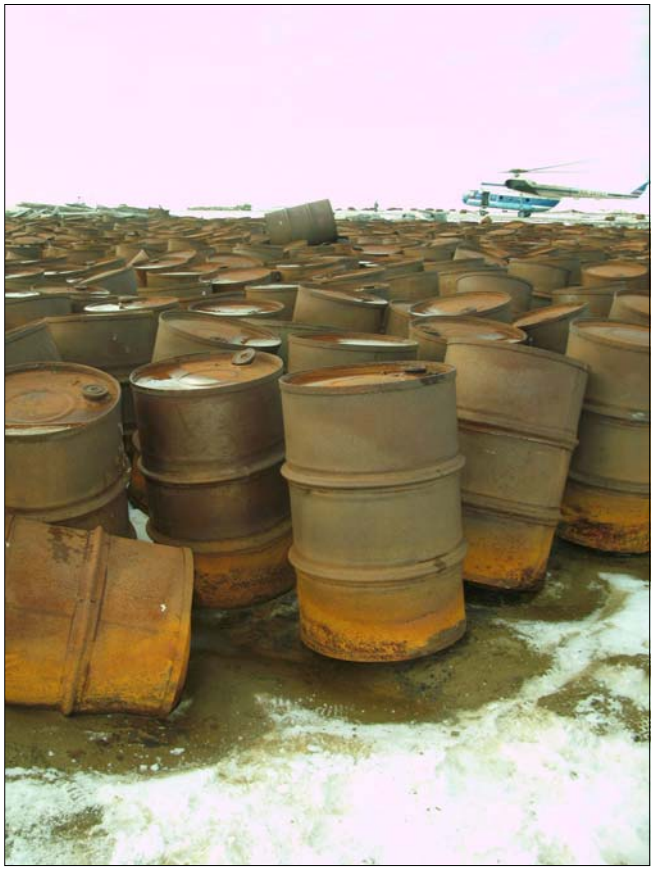


Figure 2.2-9 Fuel and lubricant storage facility on the coast area

The samples were collected from all the sites. The specimens of technical liquids were collected at sites 1, 9, 2 and 3.

Soil samples were collected in compliance with applicable regulatory documents.

The samples were collected using "envelope" method from the 0-10 cm upper layer. At each site of geoecological testing, 5 soil samples were collected. The sample was placed to a bag with a snake lock. The bag was marked with a black indelible marker in accordance with the accepted marking system. The packed sample was placed to an "ISOTERM" container. After this procedure was completed a certificate of sample was filled out. The container with the sample was placed to a freezing chamber where it was kept till the delivery to the testing laboratory.

Technical liquid samples from the drums, tanks and technical devices were collected to polycarbonate tanks. The tanks were marked with paper stickers. Certificates of samples and specimens were filled out

During the collection of samples the geographic coordinates of sampling sites were determined with GPS. The point or object where a sample was collected was photographed if possible. The Catalog of field photographic materials is given in Appendix 4. The photographic materials are stored on Disc 3 of the Materials to be submitted to Client.

A total of 46 points of geoecological testing have been positioned at 4 Alexandra Island sites, at which 230 soil samples and 9 technological liquid samples have been collected. The subtotal is 239 samples and specimens.

A total of 46 points of testing have been positioned at 4 Graham Bell sites. 230 soil samples and 8 technological liquid samples have been collected. The subtotal is 238 samples and specimens.

A total of 17 points of geoecological testing have been positioned at 3 Hoffman Island sites at which 85 soil samples have been collected.

The coordinates of geoecological testing sites are given in Table 2.2-1.

After delivered to Saint-Petersburg, the samples and specimens were submitted to the LLC "I.K.M. Engineering's" test laboratory "Marintest" for processing and analysis.

Due to a large amount of laboratory studies and tight schedule of work the North-West Branch of SPA "Typhoon's" Chemical Analytical Service was involved in the analysis of part of samples.

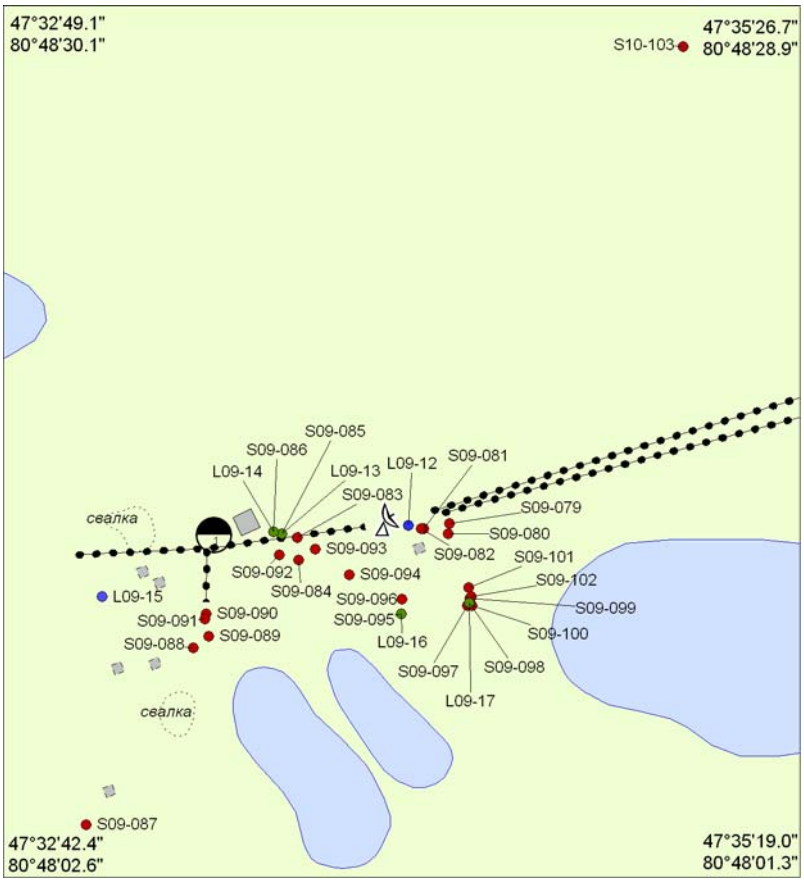


Figure2.2-10 Schematic map of the location of geoecological testing points at site 9 (radar station) on Alexandra Island (scale 1:7500)

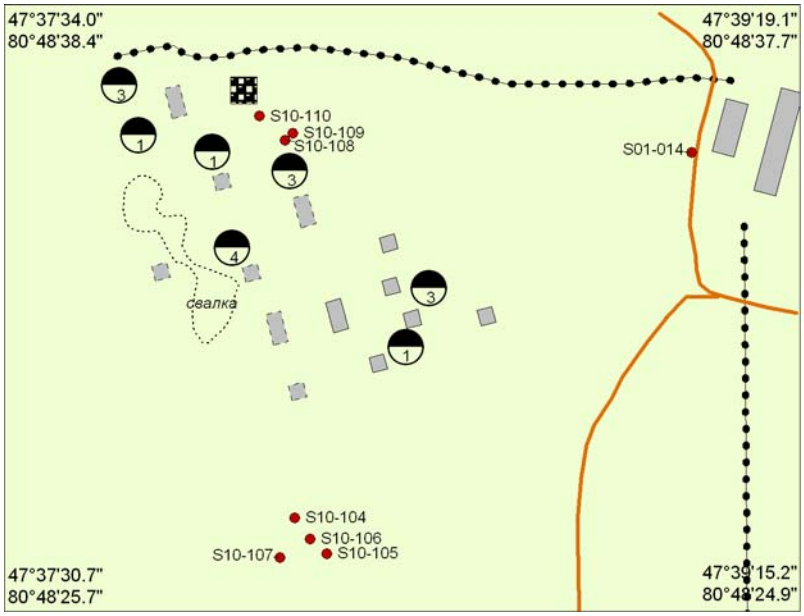


Figure2.2-11 Schematic map of the location of geoecological testing points at site 10 (fuel and lubricant storage facility near the settlement of Nagurskoe) on Alexandra Island (scale 1:5000)

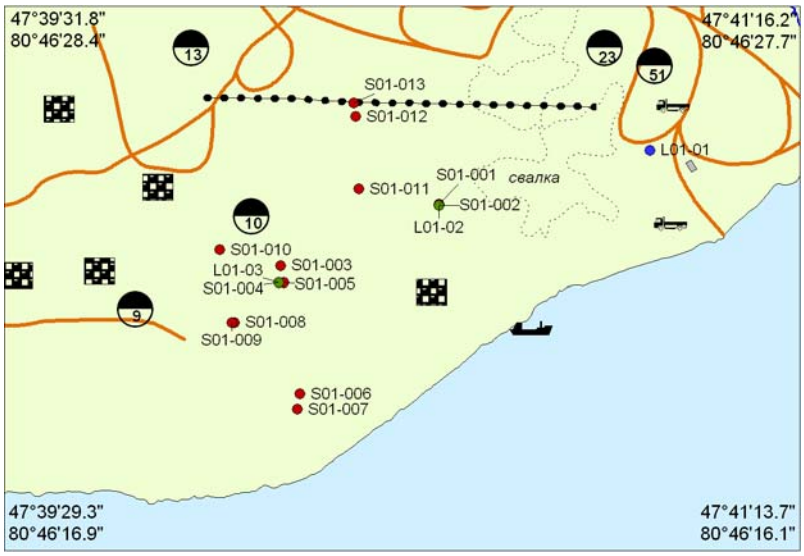


Figure2.2-12 Schematic map of the location of geoecological testing points at site 1 (fuel and lubricant storage facility in Severnaya Bay) on Alexandra Island (scale 1:5000)

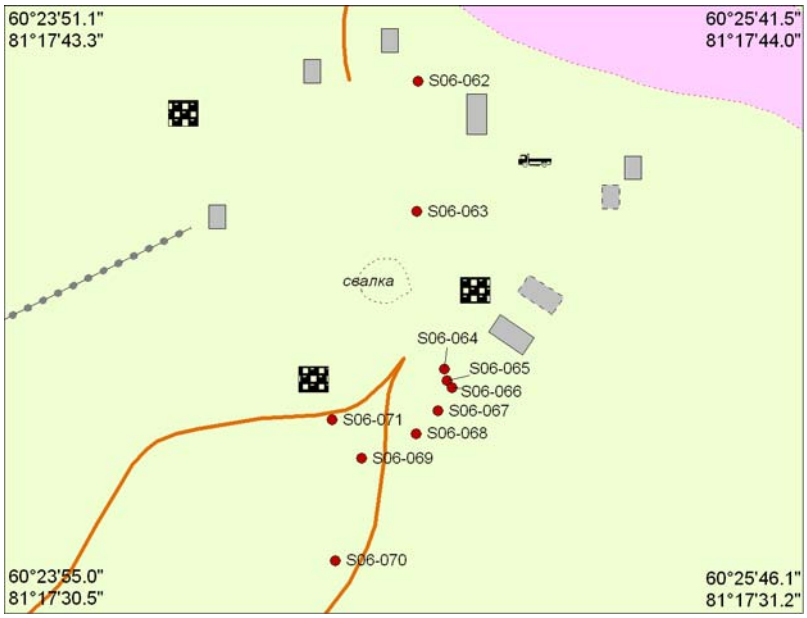


Figure2.2-13 Schematic map of the location of geoecological testing points at site 6 (settlement) on Hoffman Island (scale 1:5000)

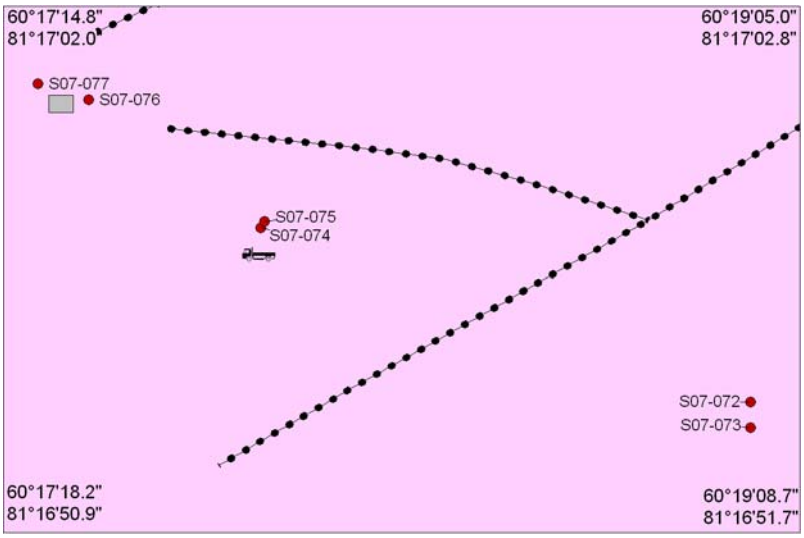


Figure2.2-14 Schematic map of the location of geoecological testing points at site 7 (drum storage facility on the glacier) on Hoffman Island (scale 1:5000)

Figure2.2-15 Schematic map of the location of geoecological testing points at site 8 (drum storage facility on the coast) on Hoffman Island (scale 1:5000)

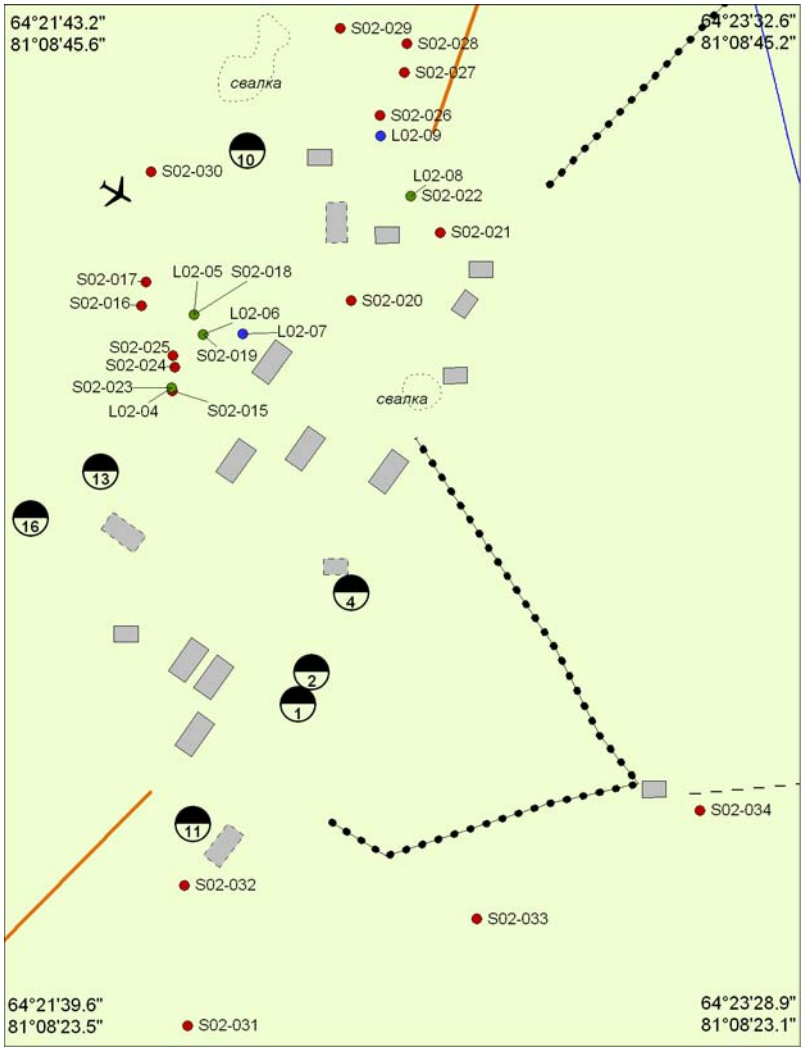


Figure2.2-16 Schematic map of the location of geoecological testing points at site 2 (aviation camp) on Graham Bell Island (scale 1:5000)

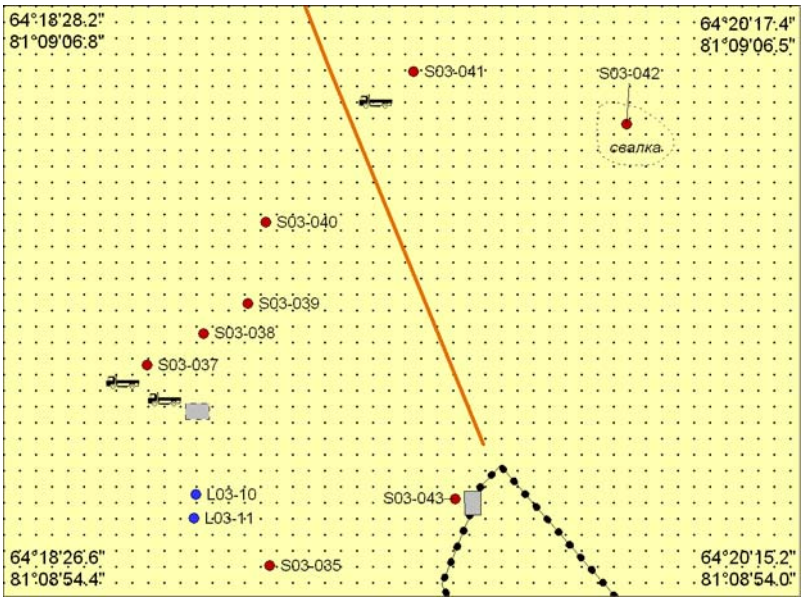


Figure2.2-17 Schematic map of the location of geoecological testing points at site 3 (landing strip) on Graham Bell Island (scale 1:5000)

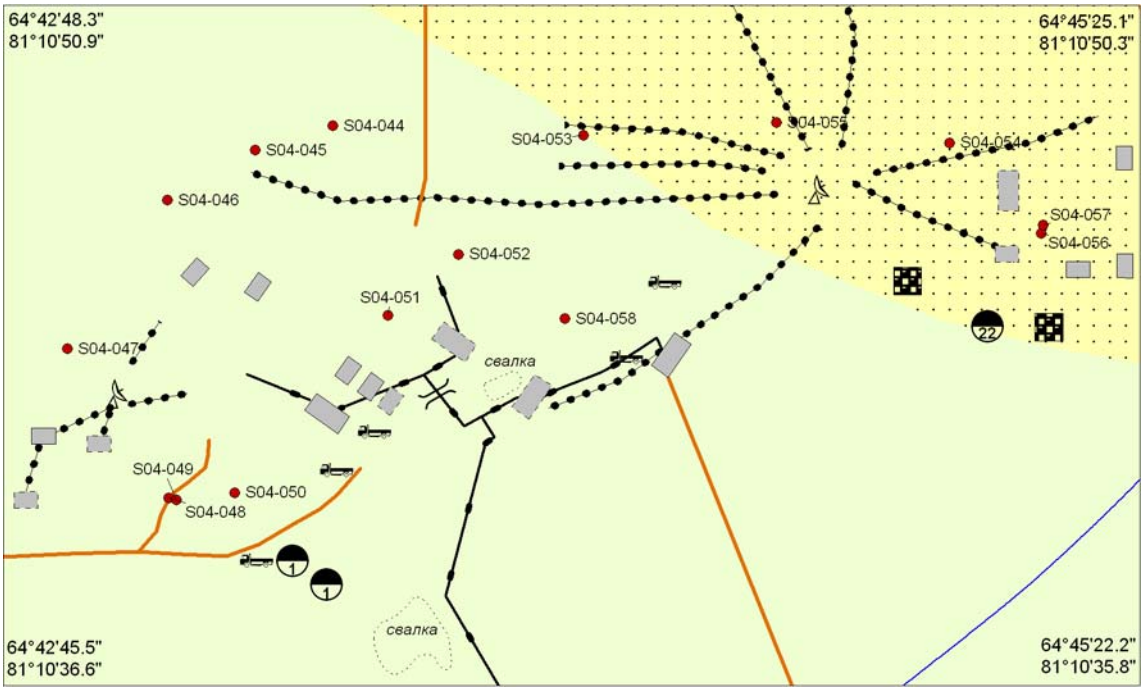


Figure2.2-18 Schematic map of the location of geoecological testing points at site 4 (air defense base) on Graham Bell Island (scale 1:5000)

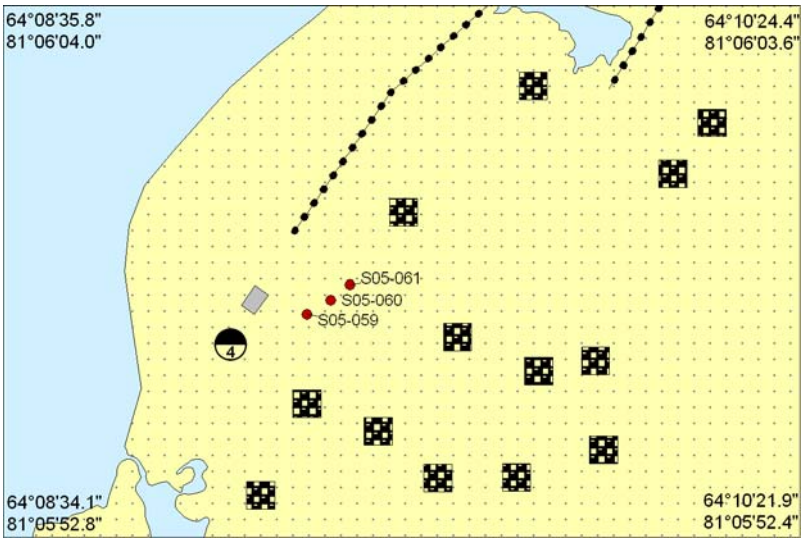


Figure2.2-19 Schematic map of the location of geoecological testing points at site 5 (drum storage facility on the coast) on Graham Bell Island (scale 1:5000)

Conventional signs for the schematic map of the location of geoecological testing points on Hoffman, Graham Bell and Alexandra Islands

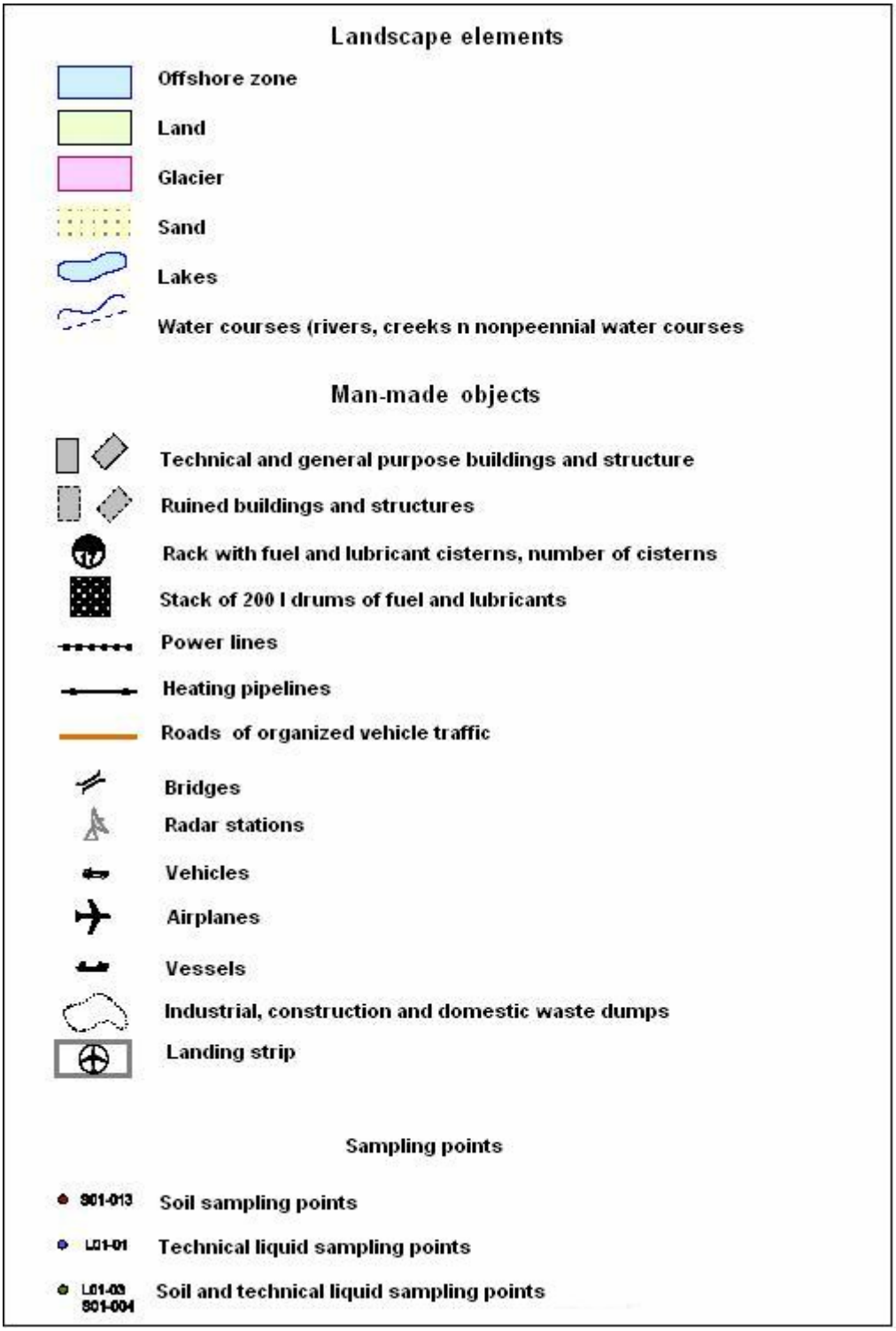


Table 2.2-1 Summary table of the location of geoecological testing points

No.	Point number	Sample number	Geographical name of sample collection point	Date of collection	Coordinates	
					latitude	longitude
			Site No. 1			
1.	S01-001	S01-001-1 - S01-001-5	Fuel and lubricant storage facility in tanks and dump of drums at Severnaya Bay on Alexandra Island	16.09.2007	80.77328° N	47.67441° E
2.	S01-002	S01-002-1 - S01-002-5		16.09.2007	80.77327° N	47.67441° E
3.	S01-003	S01-003-1 - S01-003-5		16.09.2007	80.77296° N	47.66849° E
4.	S01-004	S01-004-1 - S01-004-5		16.09.2007	80.77286° N	47.66838° E
5.	S01-005	S01-005-1 - S01-005-5		16.09.2007	80.77286° N	47.66857° E
6.	S01-006	S01-006-1 - S01-006-5		16.09.2007	80.77220° N	47.66897° E
7.	S01-007	S01-007-1 - S01-007-5		16.09.2007	80.77211° N	47.66886° E
8.	S01-008	S01-008-1 - S01-008-5		16.09.2007	80.77264° N	47.66668° E
9.	S01-009	S01-009-1 - S01-009-5		16.09.2007	80.77264° N	47.66660° E
10.	S01-010	S01-010-1 - S01-010-5		16.09.2007	80.77307° N	47.66626° E
11.	S01-011	S01-011-1 - S01-011-5		16.09.2007	80.77339° N	47.67149° E
12.	S01-012	S01-012-1 - S01-012-5		16.09.2007	80.77382° N	47.67149° E
13.	S01-013	S01-013-1 - S01-013-5		16.09.2007	80.77390° N	47.67144° E
14.	L01-001	L01-001		16.09.2007	80.77354° N	47.68227° E
15.	L01-002	L01-002		16.09.2007	80.77327° N	47.67441° E
16.	L01-003	L01-003		16.09.2007	80.77286° N	47.66838° E
			Site No. 2			
17.	S02-015	S02-015-1 - S02-015-5	Aviation camp on Hoffman Island	18.09.2007	81.14369° N	64.36803° E
18.	S02-016	S02-016-1 - S02-016-5		18.09.2007	81.14420° N	64.36691° E
19.	S02-017	S02-017-1 - S02-017-5		18.09.2007	81.14434° N	64.36712° E
20.	S02-018	S02-018-1 - S02-018-5		18.09.2007	81.14414° N	64.36893° E
21.	S02-019	S02-019-1 - S02-019-5		18.09.2007	81.14402° N	64.36925° E
22.	S02-020	S02-020-1 - S02-020-5		18.09.2007	81.14420° N	64.37496° E
23.	S02-021	S02-021-1 - S02-021-5		18.09.2007	81.14459° N	64.37845° E

Continuation of table 2.2-1

No.	Point number	Sample number	Geographical name of sample collection point	Date of collection	Coordinates	
					latitude	latitude
			Site No. 2			
24.	S02-022	S02-022-1 - S02-022-5	Aviation camp on Hoffman Island	18.09.2007	81.14481° N	64.37734° E
25.	S02-023	S02-023-1 - S02-023-5		18.09.2007	81.14371° N	64.36801° E
26.	S02-024	S02-024-1 - S02-024-5		18.09.2007	81.14383° N	64.36815° E
27.	S02-025	S02-025-1 - S02-025-5		18.09.2007	81.14390° N	64.36808° E
28.	S02-026	S02-026-1 - S02-026-5		18.09.2007	81.14529° N	64.37624° E
29.	S02-027	S02-027-1 - S02-027-5		18.09.2007	81.14554° N	64.37721° E
30.	S02-028	S02-028-1 - S02-028-5		18.09.2007	81.14571° N	64.37734° E
31.	S02-029	S02-029-1 - S02-029-5		18.09.2007	81.14581° N	64.37479° E
32.	S02-030	S02-030-1 - S02-030-5		18.09.2007	81.14499° N	64.36742° E
33.	S02-031	S02-031-1 - S02-031-5		18.09.2007	81.13994° N	64.36804° E
34.	S02-032	S02-032-1 - S02-032-5		18.09.2007	81.14077° N	64.36804° E
35.	S02-033	S02-033-1 - S02-033-5		18.09.2007	81.14053° N	64.37923° E
36.	S02-034	S02-034-1 - S02-034-5		18.09.2007	81.14114° N	64.38789° E
37.	L02-004	L02-004		18.09.2007	81.14371° N	64.36801° E
38.	L02-005	L02-005		18.09.2007	81.14414° N	64.36893° E
39.	L02-006	L02-006		18.09.2007	81.14402° N	64.36925° E
40.	L02-007	L02-007		18.09.2007	81.14402° N	64.37077° E
41.	L02-008	L02-008		18.09.2007	81.14481° N	64.37734° E
42.	L02-009	L02-009		18.09.2007	81.14517° N	64.37626° E
			Site No. 3			
43.	S03-035	S03-035-1 - S03-035-5	Landing strip on Hoffman Island	18.09.2007	81.14856° N	64.31739° E
44.	S03-037	S03-037-1 - S03-037-5		18.09.2007	81.14976° N	64.31287° E
45.	S03-038	S03-038-1 - S03-038-5		18.09.2007	81.14994° N	64.31508° E
46.	S03-039	S03-039-1 - S03-039-5		18.09.2007	81.15011° N	64.31678° E
47.	S03-040	S03-040-1 - S03-040-5		18.09.2007	81.15059° N	64.31754° E
48.	S03-041	S03-041-1 - S03-041-5		18.09.2007	81.15146° N	64.32334° E
49.	S03-042	S03-042-1 - S03-042-5		18.09.2007	81.15112° N	64.33146° E
50.	S03-043	S03-043-1 - S03-043-5		18.09.2007	81.14893° N	64.32456° E
51.	L03-010	L03-010		18.09.2007	81.14899° N	64.31464° E
52.	L03-011	L03-011		18.09.2007	81.14885° N	64.31453° E

Continuation of table 2.2-1

No.	Point number	Sample number	Geographical name of sample collection point	Date of collection	Coordinates	
					latitude	latitude
			Site No. 4			
53.	S04-044	S04-044 -1 - S04-044-5	Air defense base on Hoffman Island	18.09.2007	81.18006° N	64.72588° E
54.	S04-045	S04-045-1 - S04-045-5		18.09.2007	81.17993° N	64.72286° E
55.	S04-046	S04-046-1 - S04-046-5		18.09.2007	81.17965° N	64.71943° E
56.	S04-047	S04-047-1 - S04-047-5		18.09.2007	81.17879° N	64.71540° E
57.	S04-048	S04-048-1 - S04-048-5		18.09.2007	81.17789° N	64.71913° E
58.	S04-049	S04-049-1 - S04-049-5		18.09.2007	81.17788° N	64.71943° E
59.	S04-050	S04-050-1 - S04-050-5		18.09.2007	81.17791° N	64.72168° E
60.	S04-051	S04-051-1 - S04-051-5		18.09.2007	81.17893° N	64.72778° E
61.	S04-052	S04-052-1 - S04-052-5		18.09.2007	81.17928° N	64.73058° E
62.	S04-053	S04-053-1 - S04-053-5		18.09.2007	81.17996° N	64.73551° E
63.	S04-054	S04-054-1 - S04-054-5		18.09.2007	81.17985° N	64.74960° E
64.	S04-055	S04-055-1 - S04-055-5		18.09.2007	81.18000° N	64.74297° E
65.	S04-056	S04-056-1 - S04-056-5		18.09.2007	81.17930° N	64.75303° E
66.	S04-057	S04-057-1 - S04-057-5		18.09.2007	81.17935° N	64.75311° E
67.	S04-058	S04-058-1 - S04-058-5		18.09.2007	81.17888° N	64.73460° E
68.			***Site No. 5***			
69.	S05-059	S05-059-1 - S05-059-5	Drum storage facility on the coast on Graham Bell Island	18.09.2007	81.09926° N	64.15453° E
70.	S05-060	S05-060-1 - S05-060-5		18.09.2007	81.09934° N	64.15545° E
71.	S05-061	S05-061-1 - S05-061-5		18.09.2007	81.09943° N	64.15620° E
			Site No. 6			
72.	S06-062	S06-062-1 - S06-062-5	Settlement on Hoffman Island	18.09.2007	81.29503° N	60.41363° E
73.	S06-063	S06-063-1 - S06-063-5		18.09.2007	81.29426° N	60.41381° E
74.	S06-064	S06-064-1 - S06-064-5		18.09.2007	81.29334° N	60.41516° E
75.	S06-065	S06-065-1 - S06-065-5		18.09.2007	81.29327° N	60.41526° E
76.	S06-066	S06-066-1 - S06-066-5		18.09.2007	81.29323° N	60.41549° E
77.	S06-067	S06-067-1 - S06-067-5		18.09.2007	81.29309° N	60.41496° E
78.	S06-068	S06-068-1 - S06-068-5		18.09.2007	81.29295° N	60.41416° E
79.	S06-069	S06-069-1 - S06-069-5		18.09.2007	81.29279° N	60.41209° E
80.	S06-070	S06-070-1 - S06-070-5		18.09.2007	81.29218° N	60.41124° E
81.	S06-071	S06-071-1 - S06-071-5		18.09.2007	81.29301° N	60.41087° E

Continuation of table 2.2-1

No.	Point number	Sample number	Geographical name of sample collection point	Date of collection	Coordinates	
					latitude	latitude
			Site No. 7			
82.	S07-072	S07-072-1 - S07-072-5	Drum storage facility on the glacier on Hoffman Island	18.09.2007	81.28176° N	60.31706° E
83.	S07-073	S07-073-1 - S07-073-5		18.09.2007	81.28161° N	60.31709° E
84.	S07-074	S07-074-1 - S07-074-5		18.09.2007	81.28265° N	60.29771° E
85.	S07-075	S07-075-1 - S07-075-5		18.09.2007	81.28269° N	60.29785° E
86.	S07-076	S07-076-1 - S07-076-5		18.09.2007	81.28336° N	60.29078° E
87.	S07-077	S07-077-1 - S07-077-5		18.09.2007	81.28344° N	60.28878° E
			Site No. 8			
88.	S08-078	S08-078-1 - S08-078-5	Drum storage facility on the coast on Hoffman Island	18.09.2007	81.27940° N	60.03301° E
			Site No. 9			
89.	S09-079	S09-079-1 - S09-079-5	Radar station on Alexandra Island (radar post, air defense and HMS)	21.09.2007	80.80362° N	47.57023° E
90.	S09-080	S09-080-1 - S09-080-5		21.09.2007	80.80353° N	47.57013° E
91.	S09-081	S09-081-1 - S09-081-5		21.09.2007	80.80359° N	47.56878° E
92.	S09-082	S09-082-1 - S09-082-5		21.09.2007	80.80359° N	47.56865° E
93.	S09-083	S09-083-1 - S09-083-5		21.09.2007	80.80356° N	47.56177° E
94.	S09-084	S09-084-1 - S09-084-5		21.09.2007	80.80336° N	47.56179° E
95.	S09-085	S09-085-1 - S09-083-5		21.09.2007	80.80360° N	47.56094° E
96.	S09-086	S09-086-1 - S09-086-5		21.09.2007	80.80362° N	47.56049° E
97.	S09-087	S09-087-1 – S09-087-5		21.09.2007	80.80110° N	47.54942° E
98.	S09-088	S09-088-1 - S09-088-5		21.09.2007	80.80262° N	47.55575° E
99.	S09-089	S09-089-1 - S09-089-5		21.09.2007	80.80272° N	47.55665° E
100.	S09-090	S09-090-1 - S09-090-5		21.09.2007	80.80292° N	47.55657° E
101.	S09-091	S09-091-1 - S09-091-5		21.09.2007	80.80287° N	47.55648° E
102.	S09-092	S09-092-1 - S09-092-5		21.09.2007	80.80341° N	47.56073° E
103.	S09-093	S09-093-1 - S09-093-5		21.09.2007	80.80345° N	47.56273° E
104.	S09-094	S09-094-1 - S09-094-5		21.09.2007	80.80321° N	47.56457° E
105.	S09-095	S09-095-1 - S09-095-5		21.09.2007	80.80284° N	47.56733° E
106.	S09-096	S09-096-1 - S09-096-5		21.09.2007	80.80297° N	47.56742° E

Continuation of table 2.2-1

No.	Point number	Sample number	Geographical name of sample collection point	Date of collection	Coordinates	
					latitude	latitude
			Site No. 9			
107.	S09-097	S09-097-1 - S09-097-5	Radar station on Alexandra Island (radar post, air defense and HMS)	21.09.2007	80.80289° N	47.57103° E
108.	S09-098	S09-098-1 - S09-098-5		21.09.2007	80.80291° N	47.57112° E
109.	S09-099	S09-099-1 - S09-099-5		21.09.2007	80.80295° N	47.57119° E
110.	S09-100	S09-100-1 - S09-100-5		21.09.2007	80.80289° N	47.57128° E
111.	S09-101	S09-101-1 - S09-101-5		21.09.2007	80.80305° N	47.57115° E
112.	S09-102	S09-102-1 - S09-102-5		21.09.2007	80.80297° N	47.57124° E
113.	S10-103	S09-103-1 - S09-103-5		19.09.2007	80.80787° N	47.58570° E
114.	L09-012	L09-012		21.09.2007	80.80362° N	47.56794° E
115.	L09-013	L09-013		21.09.2007	80.80360° N	47.56094° E
116.	L09-014	L09-014		21.09.2007	80.80362° N	47.56049° E
117.	L09-015	L09-015		21.09.2007	80.80311° N	47.55085° E
118.	L09-016	L09-016		21.09.2007	80.80284° N	47.56733° E
119.	L09-017	L09-017		21.09.2007	80.80291° N	47.57112° E
			Site No. 10			
120.	S10-104	S10-104-1 - S10-104-5	Coastal fuel and lubricant storage facility on Alexandra Island	19.09.2007	80.80759° N	47.63591° E
121.	S10-105	S10-105-1 - S10-105-5		19.09.2007	80.80737° N	47.63705° E
122.	S10-106	S10-106-1 - S10-106-5		19.09.2007	80.80746° N	47.63645° E
123.	S10-107	S10-107-1 - S10-107-5		20.09.2007	80.80736° N	47.63531° E
124.	S10-108	S10-108-1- S10-108-5		20.09.2007	80.80982° N	47.63620° E
125.	S10-109	S10-109-1 - S10-109-5		20.09.2007	80.80986° N	47.63650° E
126.	S10-110	S10-110-1 - S10-110-5		20.09.2007	80.80997° N	47.63528° E
127.	S01-014	S01-014-1 - S01-014-5		16.09.2007	80.80964° N	47.65120° E

2.2.1 Regulatory documents regulating environmental assessment criteria, requirements to sampling and sample analysis procedures

Provisions on submission of information on environmental state, environmental pollution and man-made emergency situations that have had, have or can have negative environmental impact. Approved by the Russian Federation Government Decree No. 128 of 14.02.2000.

GOST 17.4.1.02-83 Nature protection. Soils. Classification of chemicals for contamination control.

GOST 17.4.3.04-85 Nature protection. Soils. General requirements for contamination control and protection.

GOST 17.4.3.06-86 Nature protection. Soils. General requirements for the classification of soils by the impact of chemical pollutants on them.

SanPiN 2.1.7.1287-03 Sanitary and epidemiological soil-quality requirements.

Health Standard 2.1.7.2041-06 Maximum permissible concentration (MPC) of chemicals in soil.

Health Standard 2.1.7.2042-06 Approximate permissible concentration (APC) of chemicals in soil

MG 2.1.7.730-99 Methodological Guidelines. Hygienic assessment of soil quality in the residential localities. Methodological Guidelines. Moscow, RF Ministry of Health, 1999.

Methodological guidelines on assessment of hazard of soil contamination with chemicals. Moscow., USSR Ministry of Health, 1987.

RD 52.44.2-94 Methodological Guidelines. Nature protection. Integrated monitoring of environmental media of industrial regions under intensive anthropogenic pressure. Roshydromet, Moscow 1996.

Criteria of assessment of environmental situation at the areas for discovering the zones of environmental emergency and zones of environmental disaster. Approved by the Ministry of Natural Resources on November 30, 1992.

Building Regulations 11-102-97 Engineering environmental site investigations for construction.

Regulatory documents regulating requirements to collection, keeping, transportation and processing of samples

GOST 17.4.3.01-83 Nature protection. Soils. General requirements for sampling.

GOST 17.4.4.02-84 Nature protection. Soils. Methods for sampling and preparation of soil for chemical, bacteriological and helminthological analysis.

GOST 28168-89 Soils. Sampling.
GOST 12071-2000 Soils. Sampling, packing, transportation and keeping of samples.

Regulatory documents regulating requirements to analysis procedure

Russian Federation Regulatory Documents

List of techniques entered in the State Register of techniques of quantitative chemical analysis. Quantitative chemical analysis of waters. Quantitative chemical analysis of soils and wastes. Quantitative chemical analysis of atmospheric air and emissions into the atmosphere. Toxicological method of control, Moscow, GUAK (State Department for Analytical Control), 1998, with amendments 1999-2007.

FR.1.31.2004.01278 Soils. Technique of measurement of mass fraction of polychlorinated biphenyls by gas-chromatographic and chromato-mass-spectrometry methods.

RD 52.18.575-96 Methodological Guidelines. Determination of total oil products in soils by infrared spectrometry method. Measurement technique.

PNDF 16.1:2.2.22-98 Technique of measurement of total oil products in soils and bottom sediments by infrared spectrometry method.
RD 52.24.473-95 Methodological Guidelines. Technique of measurement of mass concentration of volatile aromatic hydrocarbons in waters by gas-chromatographic method.
FR.1.31.2004.01279 Soils. Technique of measurement of polyaromatic hydrocarbons in soil and bottom sediment samples by high pressure liquid chromatography.
RD 52.18.685-06 Determination of metal mass fraction in soil and bottom sediment samples. Technique of measurement by atomic absorption spectrophotometry method.
RD 52.18.289-90 Soils. Methodological Guidelines. Technique of measurement of mass fraction of movable forms of metals (copper, lead, zinc, nickel, cadmium, cobalt, chrome, manganese) in soil samples by atomic absorption spectrophotometry method.
M-02-902-125-2005 Determination of acid soluble forms of As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Sn, Zn in soils and bottom sediments.
PNDF 16.1:2.3:3.10-98 Soils. Technique of measurement of mercury content in solid objects by atomic absorption spectrophotometry method (by cold vapor)
Methodological Guideline 4.1.1471-03 Atomic absorption method for determination of mercury mass concentration in soils and solid minerals
GOST 3900-85 Oil and oil products. Methods for determination of density.

GOST 33-2000 Oil products. Transparent and opaque liquids. Determination of kinematic viscosity and calculation of dynamic viscosity.

GOST 4333-87 Oil products. Methods for determination of flash and ignition points in open cup.

Soil. Quality and environmental safety control according to international standards. Reference Book. Fomin G. S., Fomin A. G. Moscow: Protector, 2001.

Sample preparation in environmental analysis. Drugov Yu. S., Rodin A. A. Saint-Petersburg, “Anatoliya”, 2002.

State standard specimens. Reference Book - Catalog 2006, Saint-Petersburg, “Anatoliya”, 2006.

Foreign Regulatory Documents (ISO, EPA and ASTM)

US EPA 680 PCBs & pesticides in water & soil/sediment.

US EPA 3510C Ultrasonic Extraction.
ISO 10382:2002 Soil quality. Determination of organochlorine pesticides and polychlorinated biphenyls-Gas-Chromatographic method with electron capture detection.
ISO 11046:1994 Soil quality - Determination of mineral oil content Method A. Method by infrared spectrometry.
US EPA-8015C Nonhalogenated Organics Using GC/FID
US EPA-3810 Headspace - Screening Method
ISO 13877:1998 Soil quality- Determination of polynuclear aromatic hydrocarbons- Method using high-performance liquid chromatography.
US EPA-600/4-81-045 (PCBs in Transformer Fluid and Waste Oils)
ASTM D 6160-98 (Standard Test Method for Determination of Polychlorinated Biphenyls (PCBs) in Waste Materials by Gas Chromatography).
ASTM D4052-96 Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter.
ASTM D5002-99 Standard Test Method for Density and Relative Density of Crude Oils by Digital Density Analyzer
ASTM D1298-99 Standard Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer.
ISO 12185:1996 Crude Petroleum and Petroleum Products – Determinationof Density. Oscillation U-Tube Method.
ASTM D 445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (The Calculation of Dynamic Viscosity).
ASTM D92-98a Standard Test Method for Flash and Fire Points by Cleveland Open Cup.
ISO 3675:1998 Crude Petroleum and Liquid Petroleum Products. Laboratory Determination of Density, Hydrometer Method.
ISO 3104:1994 Petroleum Products – Transparent and Opaque Liquids. Determination of Kinematic Viscosity and Calculation of Dynamic Viscosity
ISO 2592-73 Petroleum Products. Method for Determination of Flash and Ignition Points in Open Crucible

2.2.2 List of accepted measurement instruments, certified test and additional equipment and standard samples

Table 2.2-2 List of accepted chemical analytical and measurement instruments and certified test equipment

No.	Instruments	Date of last acceptance or certification	Number of pieces
Accepted measurement and certified test equipment			
1	Precision electronic balance Adventurer AR-2140, class 2, 0.1 mg, Ohaus, Switzerland	January 2008	2
2	Electronic balance Adventurer ARA-520, balance error 0.01 g, Ohaus, Switzerland	January 2008	2
3	Laboratory digital dosing unit Akvastep, 50 ml	February 2008	4
4	Adjustable pipettor Termoelektron	November-December 2007	10
5	Atomic absorption spectrophotometer Kvant-2 with data processing station based on IBM PC	November 2007	1
6	Atomic absorption spectrophotometer (AAS) Kvant -Z-ETA with “cold vapor” GRG-106 device.	December 2007	1
7	Atomic absorption spectrophotometer (AAS) A-02	December 2007	1
8	Oil products analyzer AN-2	September 2007	1
9	Chromatographic analytical system based on gas liquid chromatographer “Kristall-2000M” with electron capture detector, autosampler DAZh and data control and processing station based on hard and software complex Khromatek-Analitik and IBM PC.	November 2007	1
10	Chromatographic analytical system based on gas liquid chromatographer “Kristall-2000M” with flame ionization detector, equilibrium vapor dosing unit and data control and processing station based on hard and software complex Khromatek-Analitik and IBM PC.	November 2007	1
11	Chromatographic analytical system based on gradient liquid chromatograph “Stayer Gradient”, autosampler Stayer Basic, UV and fluorimetric detector and data control and processing station based on hard and software complex Multikhrom-Akvilon and IBM PC.	November 2007	1

Continuation of table 2.2-2

No.	Instruments	Date of last acceptance or certification	Number of pieces
12	Flash Point Analyzer in closed cup (Pensky Martens) LAUDA DIN 51758	September 2007	1
13	Flash Point Analyzer in open cup TVOT	October 2007	1
14	Vibration hydrometer VIP-2M	November 2007	1
15	Areometer (range of measurement 1010-950 kg/m3, scale interval 0.5 kg/m3) ANT-1	February 2008	1
16	Areometer (range of measurement 950-890 kg/m3, scale interval 0.5 kg/m3) ANT-1	February 2008	1
17	Areometer (range of measurement 890-830 kg/m3, scale interval 0.5 kg/m3) ANT-1	February 2008	1
18	Areometer (range of measurement 830-770 kg/m3, scale interval 0.5 kg/m3) ANT-1	February 2008	1
19	Viscometer MAR - TEC VISCOMAR MAR-TEC VISCOMAR	July 2007	1
20	Drying oven SNOL 58/350	February 2008	1
21	Muffle furnace SNOL 7.2/1100	February 2008	1
22	Double chamber programmable furnace PDP-18M	February 2008	1
23	Thermostat to measure oil product density according to GOST 3900-85 VT-p	February 2008	1
Additional equipment that are not subject to certification			
24	Freeze dryer Alpha-1-4, Martin Christ, Germany		1
25	Sample grinder “PULVERIZETTE”, Fritch, Switzerland		1
26	Analytical mill A-10, IKA, Germany		1
27	Bank of sieves LO 251		1
28	Centrifuge OS-6M		1
29	Automated digital laminar extractor for AN-2		2
30	Ultrasonic Cleaner Branson Ultrasonics 3510-R-MT		1
31	Ultrasonic dispersant UZD-100		
32	System for high-purity water D300, NPKF AKVILON		2
33	Rotary Evaporator RV-05 BASIC, IKA- Werke, Germany		2

Table 2.2-3 List of State reference materials, international reference materials and certified mixtures

No.	State reference materials (SRM), international reference materials (international RM), internal reference materials (internal RM) and certified solutions	Date of issue
	Russian reference materials	
1	SRM-7064-93, benz(a)pyrene, 0.1 mg/l, Ecros	August 2007
2	SRM 7248-96, oil products in carbon tetrachloride, 50 mg/ml, Water Research and Control Center (WRCC)	September 2007
3	Reference solution of hydrocarbons for IR-spectrophotometry according to OST 38.01378-85, WRCC	September 2007
4	SRM 7824-2000 (1K), set of solutions of cadmium ions, WRCC	December 2007
5	SRM 7880-2001 (8K), set of solutions of cobalt ions, WRCC	December 2007
6	SRM 7873-2000 (6K), set of solutions of nickel ions, WRCC	December 2007
7	SRM 5231-90 (27K), set of solutions of stannic ions, WRCC	December 2007
8	SRM 7879-2001 (9K), set of solutions of mercury ions, WRCC	December 2007
9	SRM 7877-2000 (2K), set of solutions of lead ions, WRCC	December 2007
10	SRM 7834-2000 (7K), set of solutions of chrome ions, WRCC	December 2007
11	SRM 7837-2000 (4K), set of solutions of zinc ions, WRCC	December 2007
12	SRM 7875-2000 (10K), set of solutions of manganese ions, WRCC	December 2007
13	SRM 7836-2000, set of solutions of copper ions, WRCC	December 2007
14	RM 17 PAH, Polynuclear aromatic hydrocarbons, solution in acetonitrile, set, Ecros	August 2007
15	ER-PAH-1 No. 0103-03, Acenaphthene, Ecros	August 2007
16	ER-PAH-2 No. 0102-03, Anthracene, Ecros	August 2007
17	ER-PAH-3 No. 0106-03, Benz(a)pyrene, Ecros	August 2007
18	ER-PAH-4 No. 0107-03, Biphenyl, Ecros	August 2007
19	ER-PAH-5 No. 0101-03, 2- Methylnaphthalene, Ecros	August 2007
20	ER-PAH-6 No. 0109-03, Naphthalene, Ecros	August 2007
21	ER-PAH-7 No. 0111-03, Phenanthrene, Ecros	August 2007
22	ER-PAH-8 No. 0112-03, Fluoranthene, Ecros	August 2007
23	ER-PAH-9 No. 0113-03, Fluorene, Ecros	August 2007
24	ER-PAH-10 No. 0104-03, Acenaphthylene, Ecros	August 2007
25	ER-PAH-11 No. 0108-03, Dibenz(a)ntracene, Ecros	August 2007
26	ER-PAH-12 No. 0110-03, Pyrene, Ecros	August 2007
27	ER-PAH-13 No. 0114-03, Chrysene, Ecros	August 2007
28	ER-PAH-14 No. 0115-03, Benz(b)fluoranthene, Ecros	August 2007
29	ER-PAH-15 No. 0105-03, Benz(a)antracene, Ecros	August 2007
	ER-PAH-16 No. 0116-03, Benz(k)fluoranthene, Ecros	August 2007
30	ER-PAH-17 No. 0117-03, Benz(ghi)perylene, Ecros	August 2007
31	ER-RAH-077, No. 118 Indeno(123cd)pyrene, Ecros	August 2007
32	SRM of arochlor solution composition -1254 7699-99	October 2006
33	SRM of arochlor solution composition -1248 7698-99	October 2006
34	SRM of arochlor solution composition -1260 7700-99	October 2006
35	Internal RM of composition of benzol 0003-03 CST (Chromatographic standard titers)	October 2007
36	Internal RM of composition of cumene 0014-03 CST	October 2007
37	Internal RM of composition of m-xylene 0015-03 CST	October 2007
38	Internal RM of composition of o- xylene 0020-03 CST	October 2007
39	Internal RM of composition of p- xylene 0022-03 CST	October 2007
40	Internal RM of composition of ethylbenzene 0034-03 CST	October 2007
41	Internal RM of composition of pseudocumene 0035-03 CST	October 2007
42	SRM of composition of toluene 7814-2000	September 2007
43	SRM of liquid viscosity 8597-2004 REV-300	April 2007
44	SRM of liquid viscosity 8593-2004 REV -80	April 2007
45	RM of liquid density 8623-2004PL-1000-EC	July 2007
46	RM of liquid density 8620-2004 PL-870-EC	July 2007
47	RM of liquid density 8618-2004 PL-810-EC	October 2007
48	SRM of flash point analyzer in open cup 8150-2002 TVOT-80- EC	January 2008
49	SRM of flash point analyzer in open cup 8153-2002 TVOT-190- EC	January 2008

Continuation of table 2.2-3

No.	SRM, RM, Internal RM and certified solutions	Date of issue
	International reference materials	
50	RPC-084S, 2,4,4'- Trichlorobiphenyl (# 28), ULTRA Scientific, USA	December 2006
51	RPC-023S, 2,4',5- Trichlorobiphenyl (# 31), ULTRA Scientific, USA	December 2006
52	RPC-031S, 2,2',5,5'- Tetrachlorobiphenyl (# 52), ULTRA Scientific, USA	December 2006
53	RPC-171S, 2,2' ,4,4',5- Pentachlorobiphenyl (# 99), ULTRA Scientific, USA	December 2006
54	RPC-039S, 2,2',4,5,5'- Pentachlorobiphenyl (# 101), ULTRA Scientific, USA	December 2006
55	RPC-098S, 2,3,3',4,4'- Pentachlorobiphenyl (# 105), ULTRA Scientific, USA	December 2006
56	RPC-106S, 2,3',4,4',5- Pentachlorobiphenyl (# 118), ULTRA Scientific, USA	December 2006
57	RPC-049S, 2,2',3,3',4,4'- Hexachlorobiphenyl (# 128), ULTRA Scientific, USA	December 2006
58	RPC-088S, 2,2',3,4,4',5'- Hexachlorobiphenyl (# 138), ULTRA Scientific, USA	December 2006
59	RPC-047S, 2,2',4,4',5,5'- Hexachlorobiphenyl (# 153), ULTRA Scientific, USA	December 2006
60	RPC-055S, 2,3,3',4,4',5- Hexachlorobiphenyl (# 156), ULTRA Scientific, USA	December 2006
61	RPC-110S, 2,2',3,3',4,4',5- Heptachlorobiphenyl (# 170), ULTRA Scientific, USA	December 2006
62	RPC-094S, 2,2',3,4,4',5,5'- Heptachlorobiphenyl (# 180), ULTRA Scientific, USA	December 2006
63	RPC-073S, 2,2',3,4,4',5',6- Heptachlorobiphenyl (# 183), ULTRA Scientific, USA	December 2006
64	RPC-111S, 2,2',3,4',5,5',6- Heptachlorobiphenyl (# 187), ULTRA Scientific, USA	December 2006
65	RPC-075N, 2,2',3,3',4,5,5',6- Octachlorobiphenyl (# 198), ULTRA Scientific, USA	December 2006
66	RPC-075S, 2,2',3,3',4,5,5',6- Octachlorobiphenyl (# 198), ULTRA Scientific, USA	December 2006
67	RPC-060S, Decachlorobiphenyl (#209), ULTRA Scientific, USA	December 2006
68	PPS-171 250 ug/mL in Acetone, 1 ml, 4,4'- dibromoctafluorobiphenyl (DBOF), ULTRA Scientific, USA	February 2007
69	RCN-011, 1,2,3,4- tetrachloronaphthalene (TCN), ULTRA Scientific, USA	March 2007
70	Reference material of a mixture of aromatic hydrocarbons hexane/toluene SRM-1491 (NIST, USA)	December 2006
71	RM Set of PAH standards PAH, 16PAH, ULTRA Scientific, USA	March 2007

3 SCOPE OF WORK

3.1 Survey of the state of man-made degradation

During the fulfillment of the Agreement, Contractor:

- Prepared electronic vector outline maps of Alexandra, Hoffman and Graham Bell Islands based on available official cartographic materials.
- Performed aerial visual survey of the areas of decommissioned sites of the Russian Federation Ministry of Defense on Alexandra Islands, Graham Bell and Hoffman and photodocumenting of man-made degradation elements.
- Analysis and interpretation of digital images in order to discover man-made degradation elements of the surveyed territories.

A total of 258 objects were geocoded on Alexandra Island

- Building, technical and general purpose structure - 55
- Rack with fuel and lubricant cisterns - 18 (194 cisterns)
- Reservoir, cistern -15
- Stack of 200 l drums of fuel and lubricants - 42
- Dump of drums - 38
- Radar station - 1
- Vehicle - 12
- Watercraft - 1
- Aircraft - 1
- Wooden rack - 2
- Power line - 14 sectors (5 km)
- Industrial, construction and domestic waste dump - 34 (125.2 thousand sq. m)
- Construction material and equipment storage yard - 5
- Traffic lane for vehicles - 16 sectors (6.7 km)

A total of 38 objects were geocoded on Hoffman Island

- Building, technical and general purpose structure - 15
- Stack of 200 l drums of fuel and lubricants - 3
- Dump of drums - 4
- Vehicle - 4
- Power line - 5 sectors (1.7 km)
- Industrial, construction and domestic waste dump - 2 (0.8 thousand sq. m)
- Construction material and equipment storage yard - 2
- Traffic lane for vehicles - 3 sectors (1.9 km)

A total of 350 objects were geocoded on Graham Bell Island, including:

- Residential and production premises - 96;
- Reservoir, cistern - 7;

- Stacks of fuel and lubricant cisterns	- 24 (number of cisterns - 384);
- Stack of 200 l drums of fuel and lubricants	- 53;
- Dump of drums	- 18;
- Radars	- 5;
- Vehicle	- 67;
- Aircraft.	-1;
- Power line	- 47 sectors (17.9 km);
- Heating pipeline	- 1 sector (670 m);
- Industrial, construction and domestic waste dump	- 14 (24.4 thousand sq. m);
- Construction material and equipment storage yard	- 4;
- Traffic lane for vehicles	- 11 sectors (7.8 km);
- Bridge	- 1;
- Landing strip	- 1;

3.2 Characteristics of the data stores chemical and environmental study results

A total of 545 soil and 17 technical liquid samples were collected during the survey of the present contamination level of the area. The number and type of samples collected at specific sites is given in Table 3.2-1.

Table 3.2-1 Composition and number of samples collected during the survey

	Sites									
	Alexandra Island			Hoffman Island			Graham Bell Island			
	1	9	10	6	7	8	2	3	4	5
Number of points	13	24	9	10	6	1	20	8	15	3
Number of soil samples	65	120	45	50	30	5	100	40	75	15
Number of technical liquid samples	3	6	-	-	-	-	6	2	-	-

The database obtained during the survey of the present contamination level of the areas of decommissioned sites of the Russian Federation Ministry of Defense on Hoffman, Graham Bell and Alexandra Islands of Franz Josef Land Archipelago includes the following:

- results of chemical analytical laboratory study of soil samples, a total of **26705 records;**
- results of laboratory study of technical liquid samples, a total of **620 records**.

Tables 3.2-2 and 3.2-3 show detailed characteristics of the database obtained during the survey of the present contamination level of the area in September, 2008.

Table 3.2-2 Number of records of the values of monitored indices in soils obtained during the survey of the present contamination level of the area

Index	Number of records / sites									
	Alexandra Island			Hoffman Island			Graham Bell Island			
	1	9	10	6	7	8	2	3	4	5
Polychlorinated biphenyls, mg/kg										
#28	65	125	40	50	30	5	100	40	75	15
#31	65	125	40	50	30	5	100	40	75	15
#52	65	125	40	50	30	5	100	40	75	15
#99	65	125	40	50	30	5	100	40	75	15
#101	65	125	40	50	30	5	100	40	75	15
#105	65	125	40	50	30	5	100	40	75	15
#118	65	125	40	50	30	5	100	40	75	15
#128	65	125	40	50	30	5	100	40	75	15
#138	65	125	40	50	30	5	100	40	75	15
#153	65	125	40	50	30	5	100	40	75	15
#156	65	125	40	50	30	5	100	40	75	15
#170	65	125	40	50	30	5	100	40	75	15
#180	65	125	40	50	30	5	100	40	75	15
#183	65	125	40	50	30	5	100	40	75	15
#187	65	125	40	50	30	5	100	40	75	15
Total PCB's	975	1875	600	750	450	75	1500	600	1125	225
Petroleum hydrocarbons, mg/kg	65	125	40	50	30	5	100	40	75	15

Continuation of Table 3.2-2

Index	Number of records / sites									
	Alexandra Island			Hoffman Island			Graham Bell Island			
	1	9	10	6	7	8	2	3	4	5
Polycyclic aromatic hydrocarbons, mg/kg										
Naphthalene	65	125	40	50	30	5	100	40	75	15
Acenaphthylene	65	125	40	50	30	5	100	40	75	15
acenaphthene	65	125	40	50	30	5	100	40	75	15
Fluorene	65	125	40	50	30	5	100	40	75	15
Phenanthrene	65	125	40	50	30	5	100	40	75	15
Anthracene	65	125	40	50	30	5	100	40	75	15
Fluoranthene	65	125	40	50	30	5	100	40	75	15
Pyrene	65	125	40	50	30	5	100	40	75	15
Benz(a)anthracene	65	125	40	50	30	5	100	40	75	15
Chrysene	65	125	40	50	30	5	100	40	75	15
Benz(b)fluoranthene + Perylene	65	125	40	50	30	5	100	40	75	15
Benz(k)fluoranthene	65	125	40	50	30	5	100	40	75	15
Benz(a)pyrene	65	125	40	50	30	5	100	40	75	15
Dibenz(ah)anthracene	65	125	40	50	30	5	100	40	75	15
Benz(ghi)perylene	65	125	40	50	30	5	100	40	75	15
Indeno(123cd)pyrene	65	125	40	50	30	5	100	40	75	15
Total PAH	1040	2000	640	800	480	80	1600	640	1200	240
Petroleum hydrocarbons, mg/kg	65	125	40	50	30	5	100	40	75	15
Highly volatile aromatic hydrocarbons, mg/kg										
Benzene	65	125	40	50	30	5	100	40	75	15
Toluene	65	125	40	50	30	5	100	40	75	15
Ethylbenzene	65	125	40	50	30	5	100	40	75	15
∑ meta- and para-Xylene	65	125	40	50	30	5	100	40	75	15
Ortho-Xylene	65	125	40	50	30	5	100	40	75	15
Isopropylbenzene	65	125	40	50	30	5	100	40	75	15
1,2,4-trimethylbenzene	65	125	40	50	30	5	100	40	75	15
Heavy metals, mg/kg										
Manganese	65	125	40	50	30	5	100	40	75	15
Zinc	65	125	40	50	30	5	100	40	75	15
Copper	65	125	40	50	30	5	100	40	75	15
Nickel	65	125	40	50	30	5	100	40	75	15
Cobalt	65	125	40	50	30	5	100	40	75	15
Lead	65	125	40	50	30	5	100	40	75	15
Cadmium	65	125	40	50	30	5	100	40	75	15
Chrome	65	125	40	50	30	5	100	40	75	15
Tin	65	125	40	50	30	5	100	40	75	15
Mercury	65	125	40	50	30	5	100	40	75	15
TOTAL	**3185**	**6125**	**1960**	**2450**	**1470**	**245**	**4900**	**1960**	**3675**	**735**

Table 3.2-3 Number of records of the values of monitored indices in technical liquids obtained during the survey of the present contamination level of the area

Index	Number of records / sites			
	Alexandra Island		Graham Bell Island	
	1	9	2	3
PCB, mkg/kg				
#28	3	6	6	2
#31	3	6	6	2
#52	3	6	6	2
#99	3	6	6	2
#101	3	6	6	2
#105	3	6	6	2
#118	3	6	6	2
#128	3	6	6	2
#138	3	6	6	2
#153	3	6	6	2
#156	3	6	6	2
#170	3	6	6	2
#180	3	6	6	2
#183	3	6	6	2
#187	3	6	6	2
Total PCB's	48	96	96	32
Density at 20°C, kg/m³	3	6	6	2
Density at 15°C, kg/m³	3	6	6	2
Viscosity at 40°C, cSt	-	3	5	-
Viscosity at 50°C, cSt	3	6	6	2
Viscosity at 100°C, cSt	3	6	6	2
Flash point in open cup TVOT, °C	3	6	6	2

The database obtained is not sufficient to assess contamination level at the surveyed territories of decommissioned sites of the Russian Federation Ministry of Defense on Hoffman, Graham Bell and Alexandra Islands

Principles of Processing and Consolidation of Information

Comparative analysis of information was conducted ob the basis of by averaging the values of indices analyzed for soils obtained in separate samples for each point.

The information on contamination level was consolidated by the sites at surveyed territories of the islands:

Alexandra Island

- Radar station (site 9);
- Fuel and lubricant storage facility near the settlement of Nagurskoe (site 10);

- Fuel and lubricant storage facility in Severnaya Bay (site 1);

Hoffman Island

- Settlement (site 6);
- Drum storage facility on the glacier (site 7);
- Drum storage facility on the coast (site 8);

Graham Bell Island

- Aviation camp (site 2);
- Landing strip (site 3);
- Air defense base (site 4);
- Drum storage facility on the coast (site 5).

In order to visualize information, the schematic maps of spatial characteristics of contamination level for separate sites were created. They were based on electronic vector schematic maps with detected man-made degradation elements in scale 1:5000. Due to the database discreteness, a regular data array was calculated with use of a local interpolation method prior to the construction of maps. The maps for regular and geocoded array of values of contamination values were constructed and formed with use of GIS MapInfo tools.

4 SURVEY OF THE PRESENT STATE OF MAN-MADE DEGRADATION OF THE TERRITORY UNDER STUDY

4.1 Procedure for the survey of man-made degradation of the territory under study

Procedures for aerial work

Aerial work included visual observation and documenting of man-made degradation of the area with the use of technical equipment.

Visual observation was carried out to:

- examine the site area to detect environmental disturbance (garbage dumps, accumulation of drums with fuel and lubricants, cisterns with fuel and lubricants on racks, buildings and technical and general purpose structures;
- preliminarily assess the general man-made degradation of the territory;

Visual observation was carried out during the whole flight. The results were recorded in a record form for visual observation results. The site location and objects to be observed, types of disturbance and detected man-made degradation elements were recorded in the form.

In case of detection of man-made degradation elements, the aircraft flew around the area to photodocument them.

Procedures for land survey of man-made degradation of the territory under study

The land survey was conducted immediately after air visual observations.

The aim of the land survey was to:

- detection, specification of man-made degradation elements;
- photodocumenting of detected man-made degradation elements;
- determination of geographical coordinates with the use of GPS and horizontal positioning of man-made degradation elements with respect to the reference objects;
- collection of soil and technical liquid samples.

4.2 Analysis of the state of the areas of decommissioned sites of the Russian Federation Ministry of Defense

4.2.1. Alexandra Island

Alexandra Island is located in the western part of FJL. The area of the island is 1039 sq. km., 74 percent of which is covered by glaciers. The glaciers Kupol Lunny and Kupol Kropotkina, 323 m and 314 m high respectively, are the highest.

The areas of decommissioned sites are located in the northern part of Alexandra Island. Their location is shown on the schematic map (figure 2.1) of sampling sites and surveyed territories.

4.2.1.1 Radar station and fuel and lubricant storage facility near the settlement of Nagurskoe

Operating frontier post and decommissioned air defense post are located on the surveyed territory of 2.9 sq. km.

A schematic map of the surveyed territory with detected man-made degradation elements is given in Book 2, Appendix 1 (Figure P1.1-1 pages 1, 2, 3). A list of detected man-made degradation elements is given in the list of geocoded objects (Table P2.1-1, Book 2 Appendix 2).
The man-made degradation of the territory is determined by the presence of buildings and technical and general purpose structures of the decommissioned air defense post, fuel and lubricant storage facilities, industrial, domestic and construction waste dumps and material and equipment storage yards.

Fuel and lubricant storage facility near the settlement of Nagurskoe (Figure P1.1-1 page 1)
The main man-made degradation elements near the settlement of Nagurskoe are tanks with fuel and lubricants – cisterns and 200 l. drums and domestic and production waste dumps.

Cisterns
8 racks (No. 15, 17, 20, 21, 22, 28, 34, 35) with 19 cisterns installed are west of the settlement of Nagurskoe. 20 cisterns are installed on 2 racks (No. 109, 110) south of the settlement near the operating airfield.

200 l. drums
200 l. drums are concentrated in 2 stacks (No. 12, 112) containing approximately 250 drums. Also in the vicinity of the settlement, 5 areas (No. 113, 114, 115, 116, 117) with accumulations of drums containing approximately 450 drums are distinguished.
In addition to the drums in stacks and dumps, the area is littered with metal drums scattered over the whole surveyed territory near the settlement of Nagurskoe. Their number is estimated at 1-2 thousand pieces.

Industrial, domestic and construction waste dumps
The industrial and construction waste dump has length of 500-600 m from north to south, west of the settlement of Nagurskoe. The total area of 7 dump areas (No. 1, 3, 4, 12, 13, 23, 27) is equal to 28 thousand sq. m.
In addition to the above, the following objects were geocoded near the settlement of Nagurskoe:

- 16 building and structures with various levels of destruction, their area is equal to 4.8 thousand sq. m;
- 9 pieces of vehicles;
- 1 aircraft (No. 111) near the fueling station.

Radar station (Figure P1.1-1 page 2)
The main man-made degradation elements are the radar station (antenna system components, power supply devices such as transformers, capacitors and other electronic elements), cisterns with fuel and lubricants on racks and dumps of metal structures and construction waste.

Radar

The radar station, i.e. antenna system (No. 76) and a production structure (No.75) is surrounded with the dump of metal structures (No.77) and other wastes and has an area of 6.5 thousand sq. m. The total area of the dumps in the vicinity of the radar station is equal to 13.6 thousand sq. m.

Cisterns

18 cisterns with fuel and lubricants are located on two 2 racks (No. 86, 88). One cistern (No.72) adjoins the building (No.73).

Buildings and structures

13 structures with various levels of destruction occupying an area of 3.9 thousand sq. m. and 1 wooden rack (No. 78) were geocoded at the radar station area.

In addition to the above objects, page 2 of the schematic map shows man-made degradation elements located between the radar station and the settlement of Nagurskoe. The area of 140 thousand sq. m. contains the following:

- 4 dumps (No. 50, 54, 70, 94) occupying a total area of 59 thousand sq. m;
- 1 rack (No. 85) with 8 cisterns on;
- 17 structures with various levels of destruction occupying an area of 5.1 thousand sq. m;
- 1 wooden rack (No.49).

The following objects were marked on the map (***Figure P1.1-1 page 3***) south of the radar station at a distance of 1.3 km:

- 3 waste dumps (No. 99, 100, 108) occupying a total area of 16 thousand sq. m,
- 8 structures with various levels of destruction occupying an area of 2.4 thousand sq. m.

In general, the area of the radar station is littered with metal drums scattered over the whole area. Their number is estimated at 1.8-3.6 thousand pieces.

The summarized characteristics of man-made degradation of the radar station area and fuel and lubricant storage facility near the settlement of Nagurskoe is given Table 4.2.

Table 4.1 Characteristics of man-made degradation of the radar station and fuel and lubricant storage facility area near the settlement of Nagurskoe on Alexandra Island

Object		fuel and lubricant storage facility, settlement of Nagurskoe	Radar station	Total
		Page 1 Schematic map P1.1-1	Pages 2,3 Schematic map P1.1-1	
1		2	3	4
Surveyed territory, sq. km		1.0	1.9	2.9
Territory with man-made degradation of soil and vegetation cover, 80 percent and more	Area, sq. km	0.85	1.5	2.35
	Area, %	85	80	80
Area littered with drums, 10-20 pieces per hectare	Area, sq. km	1.0	1.9	2.9
	Drums*, thousand pieces.	1 - 2	1.8 – 3.6	2.8 – 5.6
Area littered with drums, 20-30 pieces per hectare	Area, sq. km	-	-	-
	Drums*, thousand pieces	-	-	-
Littered area, thousand sq. m		950	1870	2820
Dumps	Number	7	13	20
	Area, thousand sq. m	28.3	88.3	116.6
Traffic lanes. km		2.3	0.8	3.1
Power lines, km		3.2	1.4	4.6
Accumulation of drums	Area, thousand sq. m	1.86	-	1.86
	Drums*, thousand pieces.	0.4 – 0.5	-	0.4 – 0.5
Reservoirs, cisterns, pieces		3	1	4
Cisterns with fuel and lubricants on racks	Number of pieces	7	3	10
	Cisterns, pieces	36	26	62

Continuation of Table 4.2

1		2	3	4
Drums with fuel and lubricants in stack	**Area, thousand sq. m**	0.09	-	0.09
	Drums*, thousand pieces	0.4 – 0.5	-	0.4 – 0.5
Buildings and structures	**Number, pieces**	16	38	54
Area occupied by buildings and structures	**thousand sq. m**	4.8	11.4	16.2
Vehicles, pieces		9	-	9
Radar station, pieces		-	1	1
Aircrafts, pieces		1	-	1
Ships, pieces		-	-	-
Storage yards, pieces		-	-	-

Note: * Number of drums is estimated

Figures 4.1-4.6 show the images of the radar station and fuel and lubricant storage facility near the settlement of Nagurskoe and man-made degradation elements.

Figure 4.1 Settlement of Nagurskoe on Alexandra Island

Figure 4.2 Fuel and lubricant storage facility near the settlement of Nagurskoe, industrial, domestic and construction waste dump (on the background)

Figure 4.3 Destroyed structures, cisterns with fuel and lubricants on the surveyed territory near the settlement of Nagurskoe (site 10, Alexandra Island)

Figure 4.4 Radar station and littered area around it on Alexandra Island (site 9)

Figure 4.5 Area littered with metal drums with fuel and lubricants in the vicinity of the radar station (Alexandra Island)

Figure 4.6 Territory with man-made degradation due to vehicle traffic in the vicinity of the radar station (Alexandra Island)

4.2.1.2 Fuel and lubricant storage facility in Severnaya Bay

The tanks of the fuel and lubricant storage facility are located at the surveyed territory having an area of 332 thousand sq. m on the coast of Severnaya Bay.
A schematic map of the surveyed territory with detected man-made degradation elements is given in Book 2 Appendix 1 (Figure P1.1-2, pages 1, 2, 3, 4). A list of detected man-made degradation elements is given in the list of geocoded objects (Table P2.1-2, Book 2 Appendix 2).
The man-made degradation of the territory in this zone is determined by the presence of stacks of 200 l. drums, industrial waste dumps and degradation of The soil cover due to organized and non-organized vehicle traffic.

Page 1 of the schematic map (Figure P1.1-2 Page 1)
19 cisterns are installed on 2 racks (No. 14 – 13 pieces, No. 25 – 5 pieces), and 1 cistern – on the ground.
200 l. drums are located on 7 stacks (No. 23, 46, 47, 48, 56, 58) and 3 areas of accumulations of drums (No. 100, 101, 102, 103). The number of drums in stacks is estimated at 4-4.5 thousand pieces, at the areas of dumps – 0.2-0.4 thousand pieces.
The area of 4 waste dumps (No. 21, 27, 49, 50) is equal to 2.3 thousand sq. m. Four material and equipment storage yards (No. 20, 129, 130, 131) were detected in the territory having an area of 400 sq. m.
The soil cover of the territory shows traces of organized and non-organized vehicle traffic. The length of traffic lanes is 1.8 km.

Page 2 of the schematic map (Figure P1.1-2 Page 2)
200 l. drums are located on stack No. 12 and 2 areas of accumulations of drums (No. 10 and 32). The number of drums in stacks is estimated at 2.5-3.0 thousand pieces, at the areas of dumps – 0.1-0.2 thousand pieces.
The soil cover of the territory shows clear traces of organized and non-organized vehicle traffic. The length of traffic lanes is 0.6 km.

Page 3 of the schematic map (Figure P1.1-2 Page 3)
The main amount of thanks with fuel and lubricants is concentrated at this area. The cisterns are installed on 3 racks (No. 57, 66, 67) having a total number of 28 pieces.
200 l. drums are located on 32 stacks (No. 56, 58-65, 67-74, 77, 80, 81, 82, 85-91, 95, 96, 98) and 25 areas of accumulations of drums. The number of drums in stacks is estimated at 19-23.0 thousand pieces, at the areas of dumps – 0.5-0.6 thousand pieces.
No storage yards are detected. The area of 3 waste dumps is equal to 500 sq. m. The length of traffic lanes is 0.5 km.

Page 4 of the schematic map (Figure P1.1-2 Page 4)

Cisterns with fuel and lubricants on racks (No. 28, 29, 31) having a total number of 86 pieces are an operating fuel and lubricant storage facility. In addition to the above, more 9 cisterns were geocoded.

200 l. drums are located on stack (No. 74) and 3 areas of accumulations of drums (No. 10, 30, 104). The number of drums in stacks is estimated at 2-2.5 thousand pieces, at the areas of dumps – 0.3-0.6 thousand pieces.

In addition to the above man-made degradation elements, one building (No.53), one vehicle and one ship (No. 94) was geocoded.

The soil cover of the territory shows clear traces of organized and non-organized vehicle traffic. The length of traffic lanes is 0.7 km.

Table 4.2 Characteristics of man-made degradation of lubricants storage facility area in Severnaya Bay on Alexandra Island

Object		Fuel and lubricant storage facility in Severnaya Bay Pages 1-4 Schematic map P1.1-2	Total
1		2	3
Surveyed territory, sq. km		0.2	0.2
Territory with man-made degradation of soil and vegetation cover, 80 percent and more	Area, sq. km	0.2	0.2
	Area, %	60	60
Area littered with drums, 10-20 pieces per hectare	Area, sq. km	0.2	0.2
	Drums* , thousand pieces.	0.2 – 0.4	0.2 – 0.4
Area littered with drums, 20-30 pieces per hectare	Area, sq. km	-	-
	Drums*, thousand pieces.	-	-
Littered area, thousand sq. m		189	189
Dumps	Number	14	14
	Area, thousand sq. m	8.6	8.6
Traffic lanes. km		3.6	3.6
Power lines, km		0.4	0.4
Accumulation of drums	Area, thousand sq. m	5.3	5.3
	Drums*, pieces	1 - 2	1 - 2
Reservoirs. cisterns, pieces		11	11
Cisterns with fuel and lubricants on racks	Number of objects	8	8
	Cisterns, pieces	132	132

Continuation of Table 4.2

1		2	3
Drums with fuel and lubricants in stack	**Area, thousand sq. m**	11.9	11.9
	Drums*, pieces	28 - 33	28 - 33
Buildings and structures	**Number, pieces**	1	1
Area, occupied by buildings and structures	**Thousand sq. m**	0.3	0.3
Vehicles, pieces		3	3
Radar station, pieces		-	-
Aircrafts, pieces		-	-
Vessels, pieces		1	1
Storage yards, pieces		5	5

Note: * Number of drums is estimated

Figures 4.7 - 4.10 show the images of fuel and lubricant storage facility area in Severnaya Bay and man-made degradation elements

Figure 4.7 Fuel and lubricant storage facility in Severnaya Bay (site 1, Alexandra Island)

Figure 4.8 Stacks of drums with fuel and lubricants in Severnaya Bay (site 1, Alexandra Island)

Figure 4.9 Cisterns with fuel and lubricants, traffic lane and waste dumps in Severnaya Bay (site 1, Alexandra Island)

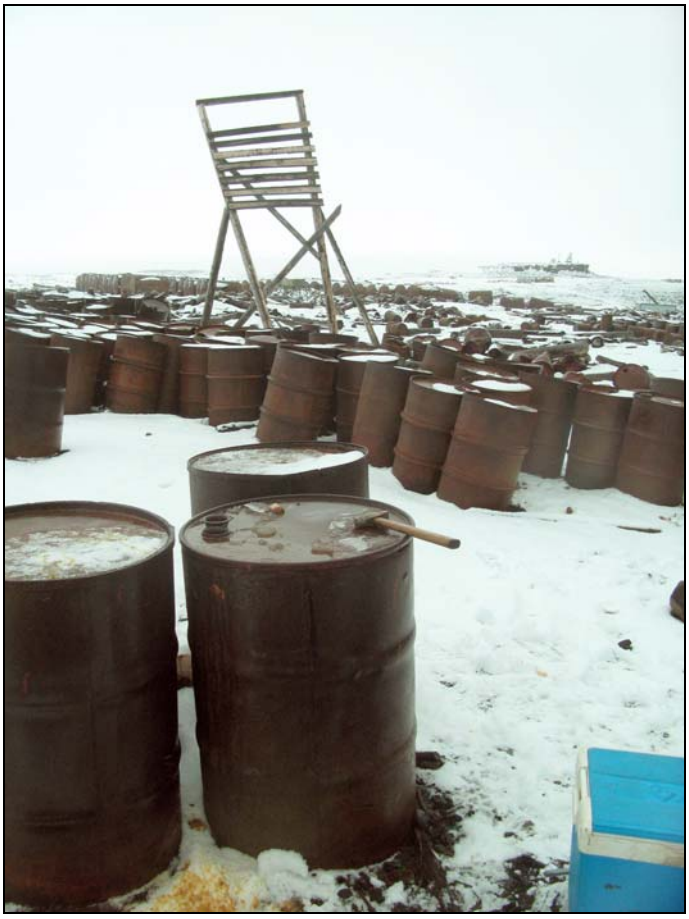


Figure 4.10 200 l. drums with fuel and lubricants in Severnaya Bay (site 1, Alexandra Island)

4.2.2 Hoffman Island

Hoffman Island is located in the northern part of FJL. The area of the island is 59.2 sq. km, 91 percent of which is covered by glacier Adamov. The glacier is not high. The height of the dome is 87.8 m.

The areas of decommissioned sites are as follows:

- settlement;
- fuel and lubricant storage facility on the glacier;
- fuel and lubricant storage facility on the coast.

4.2.2.1 Settlement

The settlement is located on the north-east coast of the island. The location of the surveyed territory is shown in the schematic map of location of sampling sites within the surveyed territory on Hoffman Island (figure 2.2). The schematic map of the settlement area with detected man-made degradation elements is given in Book 2, Appendix 1 in scale 1:5000 (Figure P1.2-1).

The main man-made degradation elements at the settlement area are as follows:

- 200 l. drums concentrated in 3 stacks 20, 23), the number of drums is estimated at 3-3.7 thousand pieces;
- metal structures, construction waste in dumps (No.16, 17);
- abandoned equipment (No. 2, 10);
- buildings and structures with various levels of destruction – 11 pieces (4, 5, 6, 9, 11, 12, 13, 14, 18, 19, 24), their area is equal to 3.3 thousand sq. m.
- the length of traffic lanes is 1.9 km;
- the areas with man-made degradation of soil and vegetation cover are found on the coast within the territory of the settlement and have an area of 0.46 sq. km (21 percent of the surveyed territory area);

The territory of the settlement is significantly littered. The area of littered territory is 77 thousand sq. m.

4.2.2.2 Drum storage facility on the glacier

The fuel and lubricant storage facility on the glacier is located in the center of the island at an elevation of 80 m above the sea level. The main man-made degradation elements are 200 l. drums concentrated at 2 areas of accumulations of drums (No. 9, 10). An estimated number of drums in those dumps is about 5 – 9 thousand pieces. Heaps of garbage can be seen around the structures at the area of 4.5 thousand sq. m.

4.2.2.3 Drum storage facility on the coast

The fuel and lubricant storage facility is located in the southern side of the island at an elevation of 20-30 m above the sea level.

The main man-made degradation elements are 200 l. drums concentrated at 2 areas of accumulations of drums (No. 2, 3). An estimated number of drums in those dumps is about 10-15 thousand pieces.

One vehicle can be seen (No.1).

Table 4.3 Characteristics of man-made degradation of the areas of the settlement and drum storage facilities on the glacier and coast on Hoffman Island

Object		Settlement	Drum storage facility on the glacier	Drum storage facility on the coast	Total
		Schematic map P1.2-1,	Schematic map P1.2-2	Schematic map P1.2-3	
1		2	3	4	5
Surveyed territory, sq. km		2.2	2.2	1.7	6.1
Territory with man-made degradation of soil and vegetation cover, 80 percent and more	Area, sq. km	0.46	-	-	0.46
	Area, %	21	-	-	21
Area littered with drums, 10-20 pieces per hectare	Area, sq. km	0.53	0.20	0.25	0.98
	Drums*, thousand pieces.	0.5 – 1.0	0.2 – 0.4	0.3 – 0.6	1.0 – 2.0
Area littered with drums, 20-30 pieces per hectare	Area, sq. km	0.04	-	-	0.04
	Drums*, thousandpieces	0.1 – 0.2	-	-	0.1 – 0.2
Littered area, thousand sq. m		76.8	4.5	-	81.3
Dumps	Number	2	-	-	2
	Area, thousand sq. m	0.8	-	-	0.8
Traffic lanes. km		1.9	-	-	1.9
Power lines, km		0.72	0.99	-	1.71
Accumulation of drums	Area, thousand sq. m	-	9.23	98.18	107.41
	Drums*, thousand pieces.	-	5 - 9	10 - 15	15 - 24
Reservoirs, cisterns, pieces		-	-	-	-
Cisterns with fuel and lubricants on racks	Number of objects	-	-	-	-
	Cisterns, pieces	-	-	-	-

Continuation of Table 4.3

1		2	3	4	5
Drums with fuel and lubricants in stack	**Area, thousand sq. m**	1.3	-	-	1.3
	Drums*, thousand pieces.	3 - 3.7	-	-	3 - 3.7
Buildings and structures	**Number, pieces**	11	4	-	15
Area, occupied by buildings and structures	**Thousand sq. m**	3.3	1.2	-	4.5
Vehicles, pieces		2	1	1	4
Radar station, pieces		-	-	-	-
Aircrafts, pieces		-	-	-	-
Vessels, pieces		-	-	-	-
Storage yards, pieces		2	-	-	2

Note: ***** Number of drums is estimated

Figures 4.11 – 4.14 show the images of the main man-made degradation elements on Hoffman Island.

Figure 4.11 Accumulation of drums with fuel and lubricants in the settlement on Hoffman Island (site 6)

Figure 4.12 Dump of metal structures in the vicinity of the settlement on Hoffman Island

Figure 4.13 Accumulation of drums with fuel and lubricants on the glacier on Hoffman Island (site 7)

4.2.3 Graham Bell Island

Graham Bell Island is located in the western part of FJL. The area of the island is 1.7 thousand sq. km., 71 percent of which is covered by glacier Kupol Vetryany. The height of Kupol Vetryany is 523 m above the sea level.

The areas of decommissioned sites are located in the northern part of the island on the Peninsula Kholmisty. The main objects are as follows:

- aviation camp;
- landing strip objects;
- air defense base;
- drum storage facility on the coast.

4.2.3.1 Aviation Camp and Landing Strip

The total area of the aviation camp and landing strip territory is 12.4 sq. km. The aviation camp and landing strip are located in the north-west part of the Peninsula Kholmisty. The location of the Aviation camp and landing strip is shown in the schematic map of location of sampling sites and surveyed territory (figure 2.3). The schematic map of the area with detected man-made degradation elements is given in Book 2, Appendix 1 (Figure P1.3-1 pages 1 - 6). The description of man-made degradation elements was included in the list of geocoded objects (Book 2, Appendix 2, Table P2.3-1). Additionally, a fuel and lubricant storage facility and parking area for vehicles on the coast were surveyed at this area.

The man-made degradation of the territory is determined by the presence of the aviation camp's technical and general purpose structures, fuel and lubricant storage facilities, landing strip, domestic and industrial waste dumps, material and equipment storage yards and vehicles and radio equipment.

Aviation camp

The schematic map of the aviation camp with detected man-made degradation elements is given in Book 2, Appendix 1 (Figure P1.3.-1, pages 1, 2).

Buildings and structures

48 building and structures with various levels of destruction within the territory of the aviation camp and 3 premises (No. 126, 118, 137) at a distance of 500 m to the west of the camp were geocoded. Their area is equal to 15.3 thousand sq. m.

Cisterns with fuel and lubricants

60 cisterns and reservoirs were detected within the territory: 56 of them are installed on racks (No. 35, 77, 109, 84, 117, 132),.

200 l. drums

200 l. drums within the territory of the aviation camp are mostly in stacks. 6 stacks were geocoded (No. 34, 50, 61, 72, 130, 138). The number of drums is estimated at 0.5 thousand.

In addition to the drums in stacks, separate drums are scattered over the area of about 1.5 sq. km. The number of drums is from 2 to 3 thousand.

Vehicles

A significant number of abandoned vehicles were found within the territory of the aviation camp. 29 vehicles were geocoded within the territory. At a distance of 200 m to the south of the settlement, a parking area with 9 vehicles was fixed (No. 139 – 147).

Domestic and industrial waste dumps

Four industrial, domestic and construction waste dumps (No. 29, 33, 43, 65) are concentrated at the north-west end of the settlement. Their total area is 2.2 thousand sq. m.

In addition to the above dumps, heaps of garbage can be seen over the whole territory of the settlement. The littered area is 300 thousand sq. m.

Landing strip

The schematic map of the landing strip with detected man-made degradation elements is given in Book 2, Appendix 1 (Figure P1.3.-1, pages 3, 4, 5).

Buildings and structures

11 service buildings (No. 7, 8, 13, 14, 17, 21, 24, 28, 30, 37, 156) located at the beginning of the landing strip were geocoded within the landing strip.

Cisterns with fuel and lubricants

The main man-made degradation elements near the landing strip are cisterns with fuel and lubricants located in the vicinity of the fueling station. 175 cisterns with fuel and lubricants on racks (No. 15, 16, 18, 19, 20, 22, 23, 26, 129) were detected within the landing strip.

200 l. drums

200 l. drums within the territory of the landing strip are mostly concentrated in accumulations of drums (No.181, 182,183) having a total area of 72 thousand sq. m. The number of drums the above dumps is estimated at from 1 to 1.5 thousand.

The territory of the landing strip is littered with metal drums scattered over the area of about 2.3 sq. km. The number of drums is estimated at from 2 to 4 thousand

Vehicles

3 vehicles (No. 3, 5, 6, 7) were geocoded within the territory of the landing strip

Domestic and industrial waste dumps

Two industrial waste dumps (No. 29, 33, 43, 65) were detected within the territory of the landing strip. Their total area is 2.9 thousand sq. m.

Fuel and lubricant storage facility and parking area for vehicles on the coast

The schematic map of the area of the fuel and lubricant storage facility and parking area for vehicles on the coast with detected man-made degradation elements is given in Book 2, Appendix 1 (Figure P1.3-1 pages 6).

The fuel and lubricant storage facility there is a accumulation of drums (No.184) having an area 28 thousand sq. m. and containing about 5.0 – 5.6 thousand drums.

A parking area for vehicles is located at a distance of 200 m to the north-west of the accumulation of drums. There are 11 vehicles (No. 160-170) at the parking area.

The territory of the fuel and lubricant storage facility on the coast is littered with metal drums scattered over the area of about 0.4 sq. km. The number of drums is estimated at from 0.6 to 1 thousand.

Table 4.4 Characteristics of man-made degradation of the areas of the aviation camp, landing strip and fuel and lubricant storage facility on the coast on Graham Bell Island

Object		Aviation camp	Landing strip	Fuel and lubricant storage facility on the coast	Total
		Pages 1,2 Schematic maps P1.3-1, P1.3-2	Pages 3-5 Schematic maps P1.3-3 – P1.3-5	Page 6 Schematic maps P1.3-6	
1		2	3	4	5
Surveyed territory, sq. km		2.0	3.5	0.2	5.7
Territory with man-made degradation of soil and vegetation cover, 80 percent and more	Area, sq. km	1.7	3.0	0.07	4.8
	Area, %	50	68	35	60
Area littered with drums, 10-20 pieces per hectare	Area, sq. km	1.0	2.3	0.2	3.5
	Drums* , thousandpieces	1.0 – 2.0	2.3 – 4.6	0.2 – 0.4	3.5 – 7.0
Area littered with drums, 20-30 pieces per hectare	Area, sq. km	0.61	-	-	0.61
	Drums*, thousand pieces.	1.2 – 1.8	-	-	1.2 – 1.8
Littered area, thousand sq. m		310	920	170	1400
Dumps	Number	4	2	-	6
	Area, thousand sq. m	2.2	2.9	-	5.1
Traffic lanes. km		1.6	2.9	0.3	4.8
Power lines, km		2.1	6.3	1.2	9.6
Accumulation of drums	Area, thousand sq. m	0	72	28.0	100.4
	Drums*, thousandpieces	-	1.0 – 1.5	5.0 – 5.6	6 - 7
Reservoirs, cisterns, pieces		4	-	-	4
Cisterns with fuel and lubricants on racks	Number of objects	6	9	-	15
	Cisterns, pieces	56	175	-	231

Continuation of Table 4.4

1		2	3	4	5
Drums with fuel and lubricants in stack	**Area, thousand sq. m**	2.14	0.36	0	2.5
	Drums*, thousand pieces	0.4 – 0.5	0.01 – 0.02	0	0.4 – 0.5
Buildings and structures	**Number, pieces**	51	11	0	62
Area, occupied by buildings and structures	**thousand sq. m**	15.3	3.0	-	18.3
Vehicles, pieces		38	3	11	52
Radar station, pieces		-	1	-	1
Aircrafts, pieces		1	-	-	1
Vessels, pieces		-	-	-	-
Storage yards, pieces		4	-	-	4

Note: * Number of drums is estimated

Figures 4. 4.14 – 4.20 show the images of the main man-made degradation elements at the territory of the aviation camp and landing strip.

Figure 4.14 Territory of the aviation camp on Graham Bell Island (site 2)

Figure 4.15 Destroyed aircraft in the vicinity of the aviation camp on Graham Bell Island

Figure 4.16 Cisterns with fuel and lubricants, ruined structures and abandoned vehicles at the aviation camp (Graham Bell Island)

Figure 4.17 Littered area of the aviation camp (Graham Bell Island)

Figure 4.18 Littered area of the landing strip on Graham Bell Island (site 3)

Figure 4.19 Abandoned vehicle in the vicinity of the landing strip (Graham Bell Island)

Figure 4.20 Radar station in the vicinity of the landing strip (Graham Bell Island)

4.2.3.2 Air Defense Base

The total area of the air defense base territory is 6.2 sq. km. The air defense base is located in the northern part of the Peninsula Kholmisty. The location of the air defense base is shown in the schematic map of location of sampling sites and surveyed territory (figure 2.3). The schematic map of the area with detected man-made degradation elements is given in Book 2, Appendix 1 (Figure P1.3-1 pages 1, 2, 3). The description of man-made degradation elements was included in the list of geocoded objects (Book 2, Appendix 2, Table P2.3-2).
The man-made degradation of the territory is determined by the presence of technical and general purpose buildings and structures, industrial, domestic and construction waste dumps, material and equipment storage yards and vehicles and radio equipment.

Buildings and structures
32 technical and general purpose building and structures with various levels of destruction within the territory of the air defense base. These are as follows: barracks, boiler, diesel and transformer rooms and storage facility buildings. They are located in the central part of the air defense base and at radar station remote sites at a distance of 500 – 600 m to the north.

Cisterns with fuel and lubricants
8 racks with cisterns were found within the territory. 6 racks (No. 22, 34, 61, 85,88,89) with 35 cisterns were located in the central part of the base and 2 racks (No. 11, 14) with 12 cisterns – at the remote sites.

200 l. drums

200 l. drums are in 5 stacks (No. 42, 46, 57, 62,86) containing 1.3-1.6 thousand drums.
In addition, drums in stacks are concentrated at 9 areas of accumulations of drums (No.98 - 106) having an area of 11.6 thousand sq. m. The number of drums in the above accumulations is estimated at 0.5-0.7 thousand pieces.
The territory of the base is also littered with metal drums scattered over a significant area. The area can be roughly estimated at 34 percent of the surveyed territory.
The territory of the air defense base is littered with metal drums scattered over the area of about 2.1 sq. km. The number of scattered drums is estimated at from 2 to 4 thousand pieces.

Vehicles
13 vehicles (No. 32 44 53 59 76 77 78 80 81 82 84 87, 91) were geocoded within the surveyed territory of the air defense base

Industrial, domestic and construction waste dumps
Six industrial waste dumps (No. 31, 33, 54, 73, 91, 93) were geocoded. Their total area is 10.8 thousand sq. m.
The most territory of the base is littered. The area of littered territory is equal to 400 thousand sq. m.

Radio equipment

There are 4 radar stations there. Two of them (No. 67, 28) are located within the territory of the air defense base; and the other two are located at the remote sites at a distance of 500 – 600 m to the north.

Table 4.5 Characteristics of man-made degradation of the area of the air defense base on Graham Bell Island

Object		Air defense baase	Total
		Pages 1-3 Schematic maps P1.3-2	
1		2	3
Surveyed territory, sq. km		3.1	3.1
Territory with man-made degradation of soil and vegetation cover, 80 percent and more	Area, sq. km	1.9	1.9
	Area, %	34	34
Area littered with drums, 10-20 pieces per hectare	Area, sq. km	2.1	2.1
	Drums* , thousandpieces	2 - 4	2 - 4
Area littered with drums, 20-30 pieces per hectare	Area, sq. km	-	-
	Drums*, thousand pieces.	-	-
Littered area, thousand sq. m		434	434
Dumps	Number	6	6
	Area, thousand sq. m	10.8	10.8
Traffic lanes. km		3.0	3.0
Power lines, km		6.3	6.3
Accumulation of drums	Area, thousand sq. m	11.6	11.6
	Drums*, thousand pieces.	0.5 – 0.7	0.5 – 0.7
Reservoirs, cisterns, pieces		3	3
Cisterns with fuel and lubricants on racks	Number of objects	5	5
	Cisterns, pieces	44	44

Continuation of Table 4.6

1		2	3
Drums with fuel and lubricants in stack	**Area, thousand sq. m**	0.58	0.58
	Drums*, thousand pieces.	1.3 – 1.6	1.3 – 1.6
Buildings and structures	**Number, pieces**	32	32
Area, occupied by buildings and structures	**Thousand sq. m**	10	10
Vehicles, pieces		14	14
Radar station, pieces		4	4
Aircrafts, pieces		-	-
Vessels, pieces		-	-
Storage yards, pieces		-	-

Note: * Number of drums is estimated

Figures 4. 4.21 – 4.23 show the images of the main man-made degradation elements at the territory of the air defense base.

Figure 4.21 Littered area near the air defense base (site 4 Graham Bell Island)

Figure 4.22 Mobile radar station at the air defense base (site 4 Graham Bell Island)

Figure 4.23 Cisterns with fuel and lubricants, abandoned truck tractor and hangar made of metal drums near the of the air defense base (site 4 Graham Bell Island)

4.2.3.3 Drum Storage Facility in the Coast

The total area of the drum storage facility in the coast is 4.3 sq. km. The drum storage facility is located in the western part of the Peninsula Kholmisty on the coast of Matusevich Bay. The location of the drum storage facility is shown in the schematic map of location of sampling sites and surveyed territory (figure 2.3). The schematic map of the area with detected man-made degradation elements is given in Book 2, Appendix 1 (Figure P1.3-1 pages 1, 2). The description of detected man-made degradation elements was included in the list of geocoded objects (Book 2, Appendix 2, Table P2.3-3).

The man-made degradation of the territory is determined by the presence of stacks of 200 l. drums with fuel and lubricants and reservoirs and cisterns with fuel and lubricants

41 stacks of 200 l. drums with fuel and lubricants are geocoded within the territory having an area of about 31 thousand sq. m. The number of drums is estimated at 70-80 thousand. Accumulations of drums due to breakdown of the stacks cover an area of 30 thousand sq. m and contain some 2-3 thousand pieces.

The territory is littered with metal drums scattered over the area of about 34 percent of the surveyed territory. The number of drums scattered is 2.5 – 5 thousand.

Soil and vegetation cover of the territory adjacent to the storage facility is damaged due to (organized and non-organized) vehicle traffic. The area of the territory with soil and vegetation cover degradation of 80 percent and more is 400 thousand sq. m which is 36 percent of the surveyed territory.

Table 4.6 Characteristics of man-made degradation of the area of the drum storage facility on the coast on Graham Bell Island

Object		Drum storage facility	Total
		Pages 1,2 Schematic maps P1.3-3	
1		2	3
Surveyed territory, sq. km		1.2	1.2
Territory with man-made degradation of soil and vegetation cover, 80 percent and more	Area, sq. km	0.4	0.4
	Area, %	36	36
Area littered with drums, 10-20 pieces per hectare	Area, sq. km	1.1	1.1
	Drums*, thousand pieces.	1 – 2	1 – 2
Area littered with drums, 20-30 pieces per hectare	Area, sq. km	0.10	0.10
	Drums*, thousand pieces	0.2 – 0.3	0.2 – 0.3
Littered area, thousand sq. m		406	406
Dumps	Number	2	2
	Area, thousand sq. m	8.5	8.5
Traffic lanes. km		-	-
Power lines, km		2	2
Accumulation of drums	Area, thousand sq. m	30	30
	Drums*, thousand pieces.	2 - 3	2 - 3
Reservoirs, cisterns, pieces		4	4
Cisterns with fuel and lubricants on racks	Number of objects	3	3
	Cisterns, pieces	105	105

Continuation of Table 4.6

1		2	3
Drums with fuel and lubricants in stack	**Area, thousand sq. m**	31	31
	Drums*, thousand pieces.	70 - 80	70 - 80
Buildings and structures	**Number, pieces**	2	2
Area, occupied by buildings and structures	**Thousand sq. m**	0.3	0.3
Vehicles, pieces		1	1
Radar station, pieces		-	-
Aircrafts, pieces		-	-
Vessels, pieces		-	-
Storage yards, pieces		-	-

Note: * Number of drums is estimated

Figures 4. 4.24 – 4.25 show the images of the main man-made degradation elements of the area of the drum storage facility on the coast.

Figure 4.24 Stacks of metal drums at the drum storage facility on the coast (site 5 Graham Bell Island)

Figure 4.25 Reservoirs, stacks of metal drums at the drum storage facility on the coast (site 5, Graham Bell Island)

5 SURVEY OF THE PRESENT CONTAMINATION LEVEL OF THE TERRITORY UNDER STUDY

5.1 Chemical and environmental characteristics the contaminant groups under control

Petroleum hydrocarbons

Total petroleum hydrocarbons

Oil and products of its processing (oil products), which are the most widely spread environmental pollutants are a complex mixture of different hydrocarbons of aliphatic (paraffinic), naphthenic and aromatic homologous series having a number of carbon atoms from 5 to 70 and organic compounds of other classes such as naphthenic acids, organic compounds of sulfur, nitrogen, etc).

According to the recommendations of Russian and international technical standards, the measurement of total petroleum hydrocarbons was conducted using a method of dispersionless IR spectrophotometry allowing to efficiently monitor the total content of the most typical group of compounds comprising the main part of oil and products of its processing such as non- polar and slightly polar hydrocarbons not sorbed on active aluminum oxide.

This group includes all branched and unbranched alkanes, naphthenic hydrocarbons without condensed nuclei. These types of hydrocarbons are an integral part of the natural geochemical background. Their presence in surface waters at levels of 10-50 mcg/l can be provided by both intake of oil products and the presence of hydrobiont and terrigeneous genesis biogenic lipids.

The content of petroleum hydrocarbons in surface and ground waters in higher concentrations is a sign of the presence of a constant pollution source.

Toxicity of aliphatic and naphthenic hydrocarbons is relatively low, however, due to their high capacity to form emulsions and surface films, their presence even in small concentrations in surface and ground waters and soils causes significant changes in oxygen metabolism, what in its turn, leads to a negative environmental effect such as mass young fish and fish embryo mortality, inhibition of plant growth, etc.

Volatile aromatic hydrocarbons (VAH)

Volatile aromatic hydrocarbons (VAH) such as benzene, toluene and ortho-, para-, and meta-xylenes are highly volatile compounds having high toxic properties, irritant effects and strong characteristic odor, which, due to their high solubility in water (100-800 mg/l) can impart an unpleasant odor and taste to water making it unfit to drink.

Also aromatic hydrocarbons are the most toxic. Due to a the high volatility of these substances even at low temperatures, their presence in natural waters can be observed only in case the presence of a constant source of new oil products and only in close proximity to such sources only.

The high volatility of this group of compounds also explains their significant toxic hazard for personnel and population through an inhalation route.

When accumulating in soils in the locations of accidental oil spill or of burning of mine dumps, the rate of evaporation of VAH significantly varies leading to the increase in the time of exposure of personnel with the simultaneous decrease of one-time concentrations in atmospheric air and leading to the chronic nature of soil (ground) water contamination with this group of pollutants.

Polycyclic aromatic hydrocarbons (PAH)

The sources of PAH intake into the environment can be divided into anthropogenic and natural ones. The natural sources are volcanic outbursts, hydrocarbon anomalies in tectonically active zones, endogenous geological processes, hydrothermal sources, hydrocarbon fluxes from gas and oil, coal and shale fields, synthesis of PAH in old and modern sedimentary rocks and forest fires. The natural processes leading to the formation of PAH in such a way can be related to the synthesis without the participation of biomass at high (1000 °C and higher), medium (400-500 °C) and low (100-150 °C) temperatures and with the conversion of the components of buried biomass in sedimentary rocks in thermal catalytic reactions at temperatures from 80 to 200 °C.

The main anthropogenic sources of PAH are related to various production processes, among which more than half of emissions come from power generation (due to incomplete combustion of organic fuels such as coal, oil products and woods. Also coke-chemical and oil processing plants and exhaust gases from vehicles make a significant contribution to the total PAH content.

It should be noted that the qualitative composition and structure of PAH from natural abiogenic sources do not differ from those of anthropogenic origin if they are formed as a result of the high and medium temperature processes while the low temperature conversion of organic matter leads to the formation of aryl and alkyl substituted hydrocarbons with a large number of substituents in the aromatic ring and with long-chain branchings.

Among PAH formed during combustion process, the compounds without substituents in the aromatic ring such as phenanthrene, fluoranthene, pyrene, chrysene, benzpyrenes and dibenzpyrenes are dominant, while the content of monomethyl substituted homologs is 3-10 times lower. The ratio of specific PAHs in combustion products does not vary significantly during the transition from one source to the other, at the same time, the prevalence of specific compounds can be explained by their higher thermodynamic stability.

The composition of polycyclic aromatic hydrocarbons of coal and oil origin differs from that of pyrolytic PAHs. In PAHs from coal fields and crude unfractionated oil, methyl derivatives of naphthalene, phenanthrene and chrysene prevail, while in unsubstituted PAHs – phenanthrene and perylene. When hydrocarbons of natural origin are dispersed, PAHs can be directly discharged into ecosystems by means of both their migration and migration of more light hydrocarbons with their further transformation to PAHs in the presence of natural catalysts

The study of trace amounts of PAHs in environmental objects is of great significance due to their relatively high chemical stability and high toxicity manifesting in their oncogenic, mutagenic and teratogenic effects and a capability to cause poisoning and disorder of the immune system when accumulating in organisms. Complex toxic effect on the organism allows to consider PAH to be the agents that transform biosphere, at the same time their effects are reflected both in current and future generations

Among detectable PAHs, benz(a)pyrene and dibenz(a,h)anthracene have the strongest oncogenic properties; during laboratory experiments, tumors appeared even in breed from infected species. The presence of alkyl substituents in the aromatic ring can both increase and decrease oncogenic activity of PAHs. For example, 3.4-8.9- and 3.4-9.10 dibenzpyrene activity decreases after the introduction of a methyl substituent at position 5 and disappeared after the introduction of two methyl groups. While acene hydrocarbon (naphthalene, anthracene) and anthanthrene activity

significantly increases after the introduction of two methyl substituents at position 2 and 6. It should be stressed that the products of PAH degradation in the environment can have even stronger oncogenic effect than initial substances under the influence of physico-chemical and microbiological factors, however, the monitoring of these PAH compounds and metabolites is a quite complex task is not practically carried out now.

Organochlorine compounds

Organochlorine compounds (OCC) are not typical for the nature; they are strictly of anthropogenic origin. OCC are the most hazardous group of persistent organic pollutants and are characterized by low water solubility (about 0.5 - 0.001 mg/l) and high lipid solubility and low solubility in organic solvents and lipids – lipophilicity, low vapor pressure (10^{-3} - 10^{-5} at 20° C) and exceptional microbiological, chemical and thermal stability.

The main persistent organochlorine compounds in the environment are organochlorine pesticides of various kinds (hexachlorocyclohexanes, DDT and its isomers, metabolites and by-products, polychlorocyclodienes, polychlorobenzenes, herbicides and defoliants based on 2,4-D acid and polychlorinated phenols) polychlorinated biphenyls (PCB) as well as polychlorodioxines and polychlorobenzofurans that have never been produced as chemical synthesis products, but have been introduced into the environment either as admixtures of other compounds or have been formed due to the burning of garbage, fires at plants producing chlorine-containing plastics, transformation of waste of paper and other material bleach.

Polychlorinated biphenyls

The group of polychlorinated biphenyls (PCB) includes 209 related compounds (known as congeners) which are the products of chlorination of diphenyl (biphenyl) and differ only in the level of substitution and mutual location of substituents.

The characteristic feature of PCB production is that it is not oriented towards the production of separate compounds by means of direct chlorination of diphenyl but their mixtures of complex composition determined by the conditions and duration of the production process. Such mixtures could contain from 20 to 71 weight percent of chlorine, and its content was usually reflected in the trade name of the product by some means or other.

Decachlorobiphenyl, a product of complete chlorination of diphenyl, was the only substance to be specially produced for the use as casting wax. Small quantities of PCB can be formed as by-products of some types of chemical synthesis during chlorination of water and thermal decomposition of chlorine-containing organic substances.

PCB mixtures have unique physical and chemical properties determining their wide use in the industry. They are as follows: nonflammability, resistance to acids and alkalis, oxidation and hydrolysis, low solubility in water, thermal resistance, wide range of dielectric characteristics and low vapor pressure at room temperature. The products synthesized and implemented as complex mixtures of polychlorinated biphenyls are liquids in a very wide range of temperatures (from –50° to 300° C).

Commercial production of PCBs began in 1929 in the US by Monsanto Company. They are oily liquids that are non-flammable, do not conduct electricity but conduct heat easily. PCBs are

resistant to acids and alkalis. Commercial mixtures of chlorination of diphenyl were marketed as Aroclor, Piranol, Inerteen (Monsanto, Westinghouse in USA), Clophen (Bayer, Germany), Fenclor (Caffaro, Italy), Kanechlor and Sibanol (Kanegafuchi, Japan),. Phenoclor and Piralen (Prodolec, France), Delor (Czechoslovakia).

Commercial products based on PCBs were widely used as dielectrics – transformer and capacitor oils, as cooling liquids in heat-exchange systems (coolants), hydraulic liquids, lubricating and seal oils as well as admixtures of herbicides. PCBs were included in the composition of plasticizers for insulation materials and plastics and used as admixtures of paints, varnishes, adhesives and color paper for copying.

In the former USSR and Russia, polychlorinated biphenyls were produced from 1934 through 1995. They were produced under trade marks of Sovol, Sovtol and Geksol. The main producers of Sovols were PA "Orgsteklo" (Dzerzhinsk), PA "Orgsintez" (Novomoskovsk) and VNITIG's (All-Union Research Institute of Herbicides, Ufa) experimental plant.

The oils containing PCB mixtures was used in KSK capacitors, which had been produced by SPA Kondensator" (Serpukhov) before 1988; and in power, high-voltage, pulse and other transformers to be produced in many places in Russia.

Intake of polychlorinated biphenyls in the environment is associated with accidental leaks from controlled close systems such as commercial transformers, capacitors, heat exchangers and hydraulic devices and also with uncontrolled release due to burning of production and domestic waste. During a long period of intensive use of PCBs in industry in many countries of the world, huge amounts of these compounds have been released into the environment, and now the contamination with these xenobiotics affects the whole biosphere. PCB's physico-chemical properties provide a long life (years and decades) in abiotic environments and the capability to accumulate in bottom sediments, soils and fatty tissues of wildlife. Along with organochlorine pesticides, PCBs are the most wide spread products contaminating water in natural water bodies. It is considered that PCB concentration in non-polluted fresh waters should not exceed 0.5 ng/l, while in moderately polluted waters – 50 ng/l.

Polychlorinated biphenyls (PCB) belong to the group of persistent organic pollutants (POP), the monitoring of which is obligatory in the industrially developed countries due to their high environmental and health hazard. Persistent organic pollutants (POP) are a group of organic compounds having toxic properties and are persistent and biologically accumulable and able to be transported for a long distance in different environments to lead to negative consequences for human health and the environment.

PCB hazard for human health is, in the first place, that they impair immune system function ("chemical" AIDS). In addition, PCB intake in human organism leads to the development of cancer injury of liver, kidneys, nervous system and skin (neurodermatitis, eczemas and rashes). Penetrating into baby/fetus organism, PCBs may cause congenital deformities (developmental delay, decrease in immunity and impairment of hematogenesis). However, the most hazardous PCB impact on human health is the mutagenic effect, which is detrimental to future generations.

Heavy metals

The study of heavy metal content levels is one of the priority tasks of environmental monitoring.

Cadmium, lead, copper, nickel, cobalt, chrome, mercury are amongst the most toxic pollutants that penetrate into the environment objects both due to geochemical processes and anthropogenic factors.

Although Iron, manganese and zinc are less toxic, they play an important role in geochemical behavior of other toxic metals.

The toxic effect of heavy metals can be absolutely different depending on the chemical form of the element. For example, if chelating or complexing organic agents are present, the toxic effect becomes less pronounced than the direct effect of ionic forms of heavy metals since organometallic complexes are absorbed significantly less. And vice versa, some organometallic compounds (for example, polybasic organic acids) are much more strong poisons than metals in complete form

Many of them are used in agriculture as insecticides and pesticides

Similar compounds can be formed in surface waters with high organic matter content during microbiological processes.

High coefficients of accumulation of heavy metals (from 1000 to 10000) in biological objects, which increases as it is passed through the food web from the lowest trophic level to the highest making it extremely difficult to determine maximum allowable concentrations for specific elements. In addition, lead, cadmium, mercury and some other heavy metals also show considerable mutagenic activity.

The levels of heavy metal content along with other factors determine, to a great extent, the nature and intensity of microbiological and biochemical processes in an active layer of water.

5.2 Description of the methods of laboratory chemical analytical study

When determining pollutants in soil samples, certified analysis techniques were used recommended for the monitoring of environmental objects and included in the Federal Register.

Physical characteristics of technical liquids were measured according to effective Russian GOST and GOST R requirements and international standards ASTM and ISO recommended for implementation before the approval of a corresponding national standard).

PCB content in technical liquids was measured according to the international standard ASTM, since no similar oil analysis technique exists.

The correspondence of Russian and international analysis techniques (EPA, ASTM and ISO) is given in Table 5.2-1.

Table 5.2-1 Correspondence of Russian and international techniques of quantitative chemical analysis of soils and bottom sediments

Parameter to be determined	Technique (or its equivalent)	Russian equivalent
PCB	EPA-8080A/ 3550C ISO 10382:2002	FR.1.31.2004.01278
PAH	EPA - 8310A / 3550C ISO 13877:1998	FR.1.31.2004.01279
Petroleum hydrocarbons	EPA-0418.1 ISO 11046:1994	RD 52.18.575-96 PNDF 16.1:2.2.22-98
VAH	EPA 8015C + EPA 3810 ISO 15009	RD 52.24.473-95
Heavy metals:		
Cd	EPA 7131A	RD 52.18.685-2006
Cr	EPA 7191	RD 52.18.685-2006
Ni	EPA 7521	RD 52.18.685-2006
Co	EPA 7201	RD 52.18.685-2006
Mn	EPA 7461	RD 52.18.685-2006
Cu	EPA 7211	RD 52.18.685-2006
Pb	EPA 7421	RD 52.18.685-2006
Zn	EPA 7951	RD 52.18.685-2006
Sn	EPA 0282.2	M-02-902-125-2005
Hg	EPA 7471A	MUK 4.1.1471-03 PNDF 16.1:2.3:3.10-98
Liquid density, areometry	ASTM D1298-99 ISO 3675:1998 ISO 3838:1983	GOST 3900-85 GOST R 51069-97
Liquid density, digital technique	ASTM D4052-96 ASTM D5002-99 ISO 12185:1996	Russian standards and technical specifications recommend: ISO 12185:1996 ASTM D5002-99
Liquid viscosity	ASTM D 445 ISO 3104:1994	GOST 33-2000
Flash point in open cup	ASTM D92-98a ISO 2592-73	GOST 4333-87

5.2.1 Description of the methods of soil analysis

Polychlorinated biphenyls (PCB)

Preparation of Soil Samples for Analysis

A representative soil sample dried to a constant weight on a lyophilizer during 48 hours and milled in FRISTCH Pulverisette was sieved through a 0.1 mm mesh screen and additionally homogenized in an analytical mill A-10 for 3 minutes. A weighed portion of sample (20 grams) was put into a Teflon extraction test tube; 500 mcl of 100 ng/ml DBOFB mixture in methanol and 500 mcl of 100 ng/ml PCB#198 mixture in acetone were added; the test tube was sealed with a cap and shooken for 30 minutes. The samples were consequently extracted with 30 ml of acetone, 30 ml of hexane/acetone mixture (1:1) and 30 ml of hexane in an ultrasonic disperser. After each extraction the samples were centrifuged at 4000 rpm for 30 minutes. Extracts of each sample were placed in a separating funnel and washed the resulting extract with 150 ml of 5 percent sodium chloride solution in water; wash water additionally extracted 20 ml of hexane. The hexane extract washed out with water was dried with anhydrous sodium sulfate and concentrated on a rotary evaporator with a special up to 1 ml reservoir.

Figure 5.2-1 Lyophilizer

The samples were purified from sulfur compounds with saturated sodium sulfite solution in 50 percent isopropyl alcohol with tetrabutylammonium (TBA) hydrosulfate added as a phase-transfer catalyst and shaking up with metallic activated copper.
Then the concentrate was purified on a preparative column with Florisil modified with 1 percent of water; 40 ml of hexane and 80 ml of hexane/dichloromethane mixture (4:1) chlororganic compounds were eluted. The eluate was concentrated on the rotary evaporator up to 2 ml volume in hexane, put into a graduated test tube and evaporated to 1 ml with nitrogen gas; then the output control standard – 50 ng of naphthalene tetrachloride (TCN) was added to 10 mcl of hexane. A 10 ml aliquot was placed in the chromatograph.

Measurements

Quantitative analysis of organochlorine compounds was performed using gas chromatography method with electron capture detector (ECD).
Quantitative assessment of polychlorinated biphenyl content was performed using absolute target component calibration and two internal standards, i.e. DBOFB and PCB#198 which had been added to the sample before the sample preparation.
The degree of PCB extraction was assessed using an extraction standard - naphthalene tetrachloride added to the sample immediately prior to their analysis. Extraction ratio from 50 to 110 percent was considered satisfactory; when this range was exceeded a new portion of sample was extracted. A real range of extraction ratio for all of the samples was from 54 to 89 percent.
Routine analysis was performed using a measuring system consisting of Kristall-2000m chromatograph with electron capture detector, autosampler DAJ-2 and chromatographic information processing system Chromatec Analytic version 2.0. Chromatograph's units operating mode is given in Table5.2-2

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Table 5.2-2 Chromatograph system operating mode and analysis parameters

Injector	
Temperature	280 C
Split	1:10 after delay
Septum airflow	2 ml/min
Split and airflow delay	30 s
Detector ECD	
Temperature	320 C
Feeding gas	Nitrogen, 25 ml/min
Thermostat Program	
Initial temperature	60 C
Heating	1 min
Heating rate	4 C/min
Final temperature	290
Column	Zebron ZB-5MS
	30m x 0.25mm x 0.25um
Carrier gas	H_2, 1 ml/min, constant flow
Injection	Split / Splitless

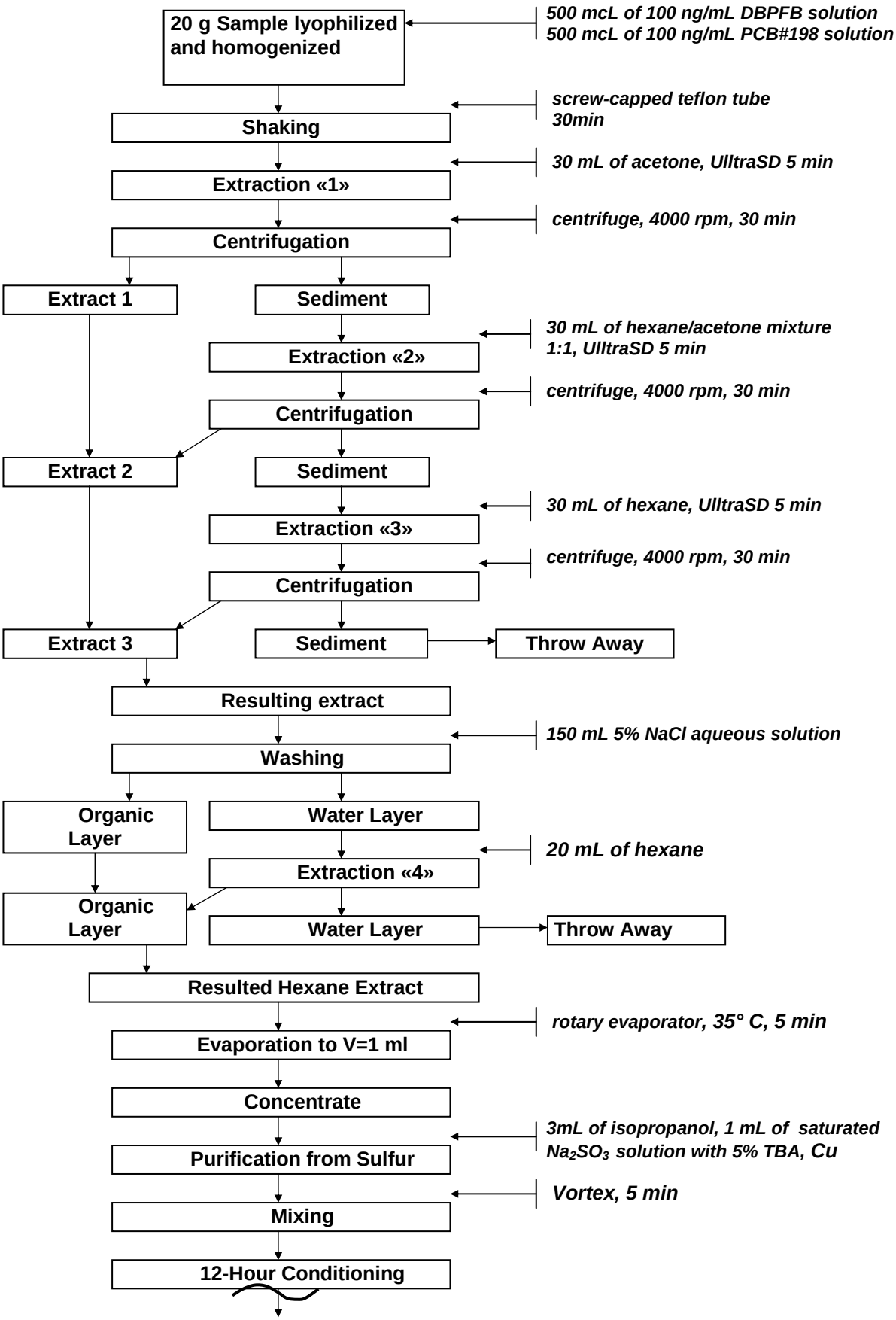
All gases used for analysis had a grade of at least 5-0. The chromatograph was supplied with hydrogen from a hydrogen generator GVCh-12.

Figure 5.2-2 PCB analysis with a chromatograph analytical system based on gas-liquid chromatograph “Kristall-2000M” with electron capture detector

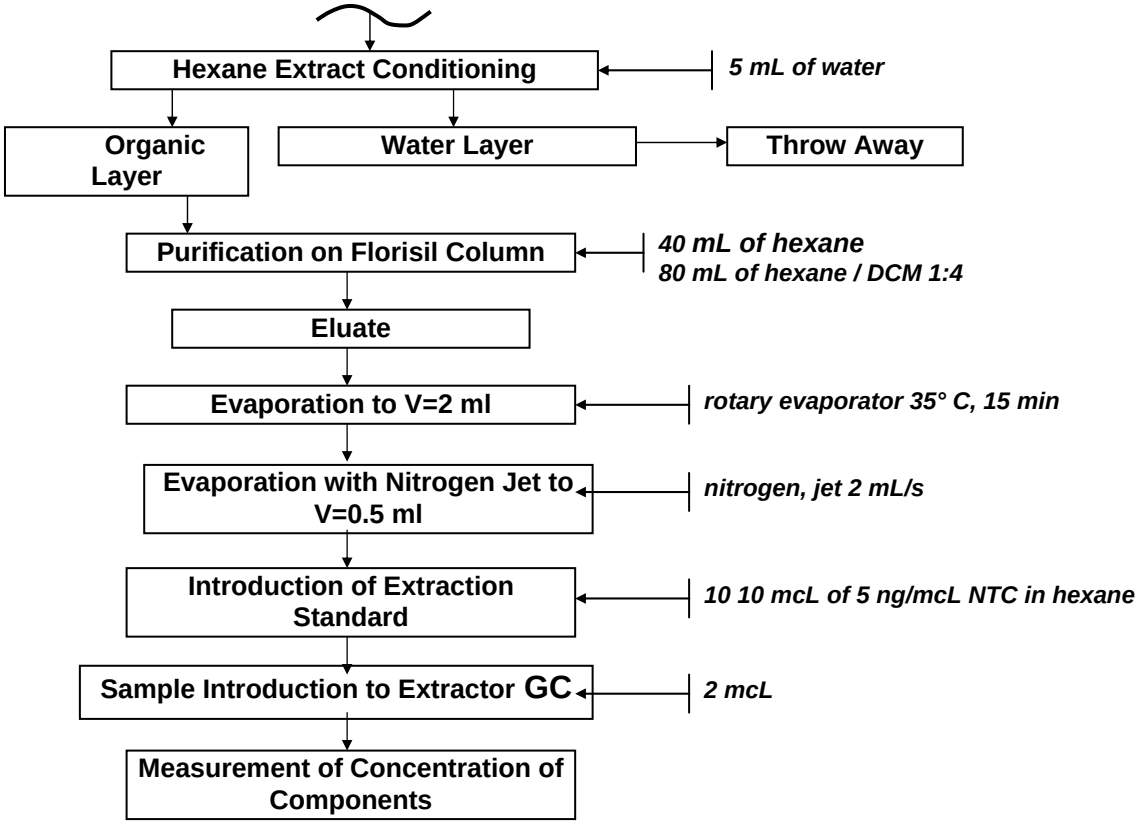
All PCB standard solutions used for calibrations were ISO9001 certified (produced by Ultra Scientific (USA).

The soil analysis for PCB content scheme is given in Figure 5.2-3.

Figure 5.2-3 Soil analysis for PCB content scheme



Continuation of Figure 5.2-3



Polycyclic aromatic hydrocarbons (PAH)

Preparation of soil samples for analysis

A representative soil sample dried to a constant weight on a lyophilizer during 48 hours and milled in FRISTCH Pulverisette was sieved through a 0.1 mm mesh screen and additionally homogenized in an analytical mill A-10 for 3 minutes. A weighed portion of sample (20 grams) was put into a Teflon extraction test tube. To control analytical errors, some quantity of 2-methylanthracene, a solution with concentration 500 ng/ml (internal standard) was added. Then the samples were processed with 30 ml of methanol by ultrasound for 5 minutes. Methanol extract was separated by centrifugation only in 24 hours, and then the samples were extracted by ultrasound in two portions by 30 ml of hexane for 5 and 10 minutes.

The extracts of each sample were placed in a separating funnel and washed the resulted extract with bidistilled water for 1 minute using a turbine stirrer. If emulsion was formed, the resulting extract was placed in an ultrasonic bath for 10 minutes and then water methanol layer was separated. The washed hexane extract was dried with anhydrous sodium sulfate and concentrated on a rotary evaporator with a special up to 1 ml reservoir at a temperature less than 40° C

The concentrated extract was purified by a preparative column chromatography. The extract was quantitatively put in the chromatographic column of 8-10 mm in diameter, filled-up with thick suspension of 6-8 g of silicone gel in hexane. During the first stage of purification, 10 ml of hexane nonpolar impurities were eluted and this fraction was thrown away. PAHs were eluted with 30 ml of hexane-ethyl acetate mixture (95:5 percent). The purified extracts obtained were concentrated on the rotary evaporator up to 1-2 ml put in vials and evaporated to 1 ml with special purity nitrogen jet. The dry extract was immediately dissolved 1 ml of acetonitrile and purified by filtering through 0.45 mcm replaceable syringe Teflon membrane filters.

Measurements

A high-efficiency liquid chromatograph system of “Stayer Gradient” series was used for analysis equipped with HPLC column Envirosep PP specific for PAHs, autosampler Stayer Basic and a set of detectors providing for spectrometric and fluorimetric measurements of PAH concentration. The chromatograph system configuration is given in Table 5.2-3, analysis parameters – in Table 5.2-4.

Spectrometric absorption measurement was carried at 255 nm wave for all PAHs except naphthalene, acenaphthene and acenaphthylene, which were measured 220 nm wave

The fluorescent detector is selective and sensitive for such substances as anthracene, fluoranthene, benz(v)fluoranthene, benz(k)fluoranthene, benz(a)pyrene, and benz(ghi)perylene.

The detector has linear characteristics for those components in range 0.5–100 ng.

The soil analysis for PAH content scheme is given in Figure 5.2-4

Table 5.2-3 Chromatograph system configuration:

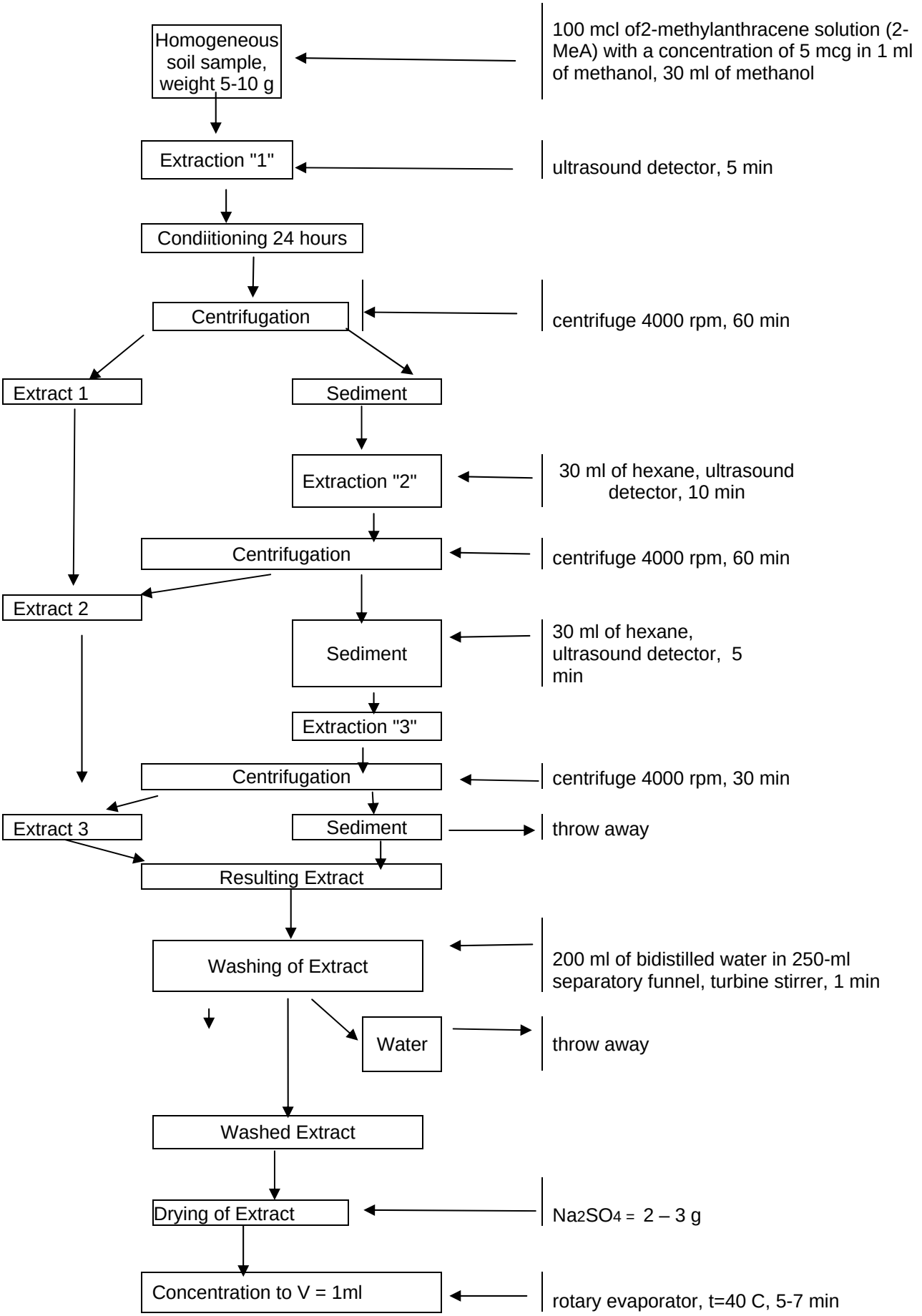
Analytical system	High-efficiency liquid chromatograph system of “Stayer Gradient” series
Detector	UV- spectrometric or diode matrix fluorimetric detectors
Dosing unit	Carousel autosampler “Akvilon-Basic”

Column	Envirosep PP 125mm*3.2mm*5um
Pre-packed column	Envirosep PP 30 mm*4.6 mm*7 um and/or Security Guard
Chromatographic oven	Temperature 30° C
Control PC	Pentium 4 with MultiChrome Software v. 2.x for Windows XP

Table 5.2-4 High-efficiency liquid chromatograph system parameters

Sample volume	20 mcl
Solvent consumption	0.75 ml/min
Elution mode	2 min. 40 percent of acetonitrile – 60% percent of water, then: during 25 min - linear growth of acetonitrile concentration up to 100 percent, then: 8 min. – 100 percent of acetonitrile
UV – spectral detector	Signal is registered at a range from 220 to 254 nm
Diode matrix detector	Signal is registered at a range from 220 to 310 nm
Fluorimetric detector	Excitation filters with a band-pass width of 305-395 nm, emission filter with a band-pass width of 410-490 nm, RFU range: 0.1 – 0.02 Time constant – 0.5 s

Figure 5.2-4 Soil analysis for PAH content scheme



Continuation of Figure 5.2-4

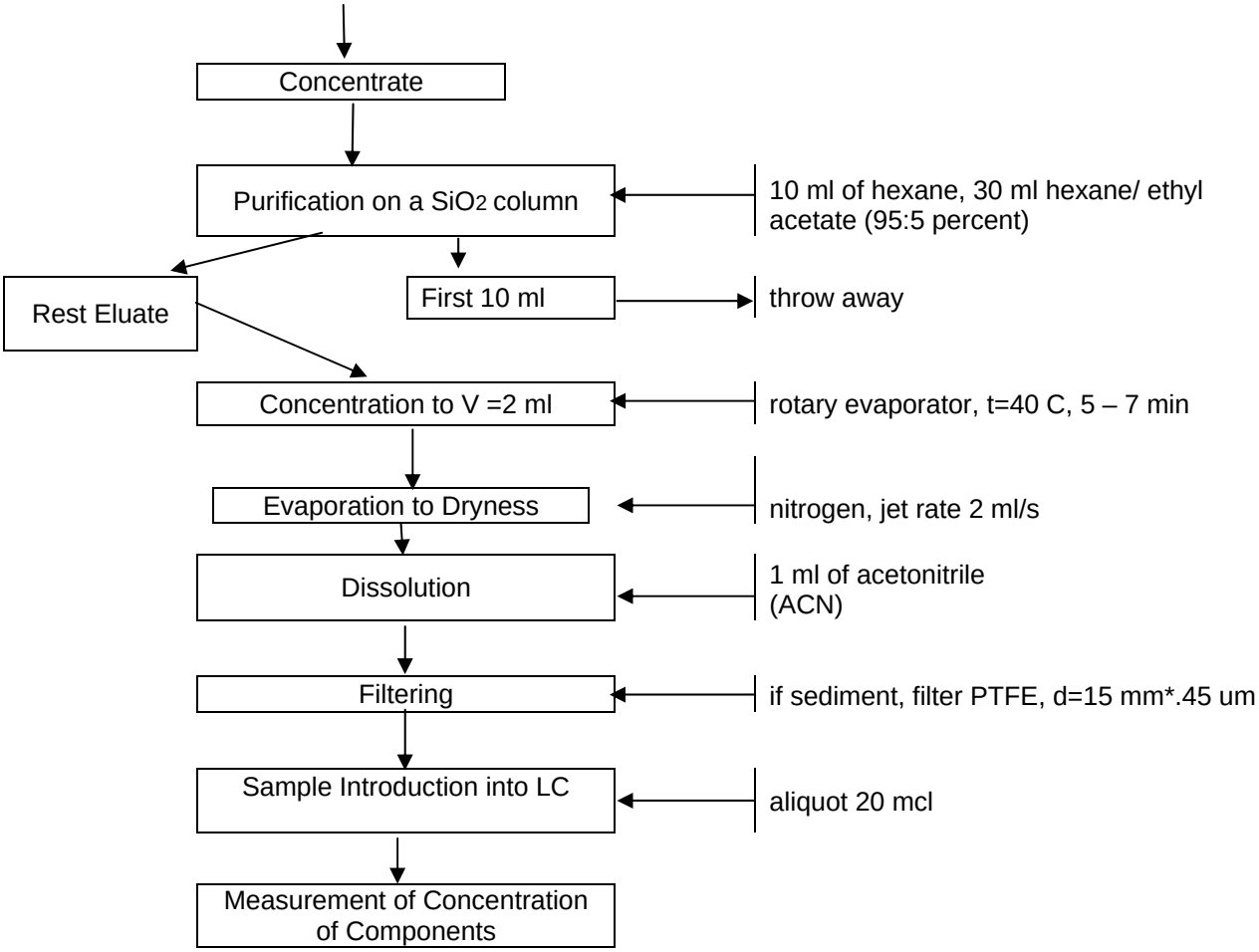


Figure 5.2-5 PAH analysis at chromatograph analytical system based on gradient liquid chromatograph "Stayer Gradient", autosampler Stayer Basic and UV and fluorimetric detectors

Volatile aromatic hydrocarbons (VAH)

Preparation of soil samples for analysis

The preparation of samples for analysis consisted of preparation of suspension having the natural moisture in water (1:4) and implementation of the procedures according to the requirements of RD 52.24.473-95 "Methodological Guidelines. Technique of measurement of mass concentration of volatile aromatic hydrocarbons in waters by gas-chromatographic method" similar in terms of analysis procedures to US EPA-3810 and US EPA-8015C.

Measurements

The determination of volatile aromatic hydrocarbons (VAH) was performed by the method of gas-liquid capillary chromatography of saturated vapor (Head Space) with flame ionization detection. To perform quantitative analysis, chromatograph "Kristall-2000M" with a flame ionization detector and equilibrium vapor dosing unit was used. Chromatographicic information was processed with the use of Chromatec Analytic 2.0 software. The analysis results were translated to the weight of dry soil. Soil moisture was measured in parallel weigh. The chromatograph units operating mode is given in Table 5.2-5.

Table 5.2-5 Chromatograph system operating mode and analysis parameters

Injector	
Temperature	280 C
Split	1:10 after delay
Septum airflow	2 ml/min
Split and airflow delay	30 s
Flame ionization detector	
Temperature	300 C
Feeding gas	Helium, 20 ml/min
Thermostat Program	
Initial temperature	60 C
Heating	1 min
Heating rate	10 C/min
Final temperature	180
Column	Zebron ZB-5MS
	60 m x 0. 5 mm x 0.25 um
Carrier gas	H_2, 1 ml/min, constant flow
Injection	Split / Splitless
Equilibrium vapor dosing unit	80 C, loop 100 mcl

Figure 5.2-6 VAH analysis at the chromatographic analytical system based on gas-liquid chromatograph “Kristall-2000M” with a flame ionization detector

Oil products (total)

Preparation of soil samples for analysis

A representative soil sample dried to a constant weight on a lyophilizer during 48 hours and milled in FRISTCH Pulverisette was sieved through a 0.1 mm mesh screen and additionally homogenized in the analytical mill A-10 for 3 minutes. A weighed portion of sample (10 grams) was put into a Teflon extraction test tube

Then 30 ml of tetrachloromethane were added to the sample and extracted with ultrasound during 5 min. The resulting extract was separated by centrifugation

The extract was purified by a preparative column chromatography. Before filtering through a column, the extract was dried with anhydrous sodium sulfate.

About 2 cm calcined aluminum oxide layer was loaded into the chromatographic column. Aluminum oxide was moistened with some milliliters of tetrachloromethane, which then was collected and thrown away. The extract was passed through the column; the flask was rinsed with 2-3 ml of tetrachloromethane, the extract was loaded into the column and collected in a measuring cylinder.

Measurements

A quantitative determination was carried out using infrared spectrometry on a nondispersive infrared spectrometer AN-2.

A working standard solution was made of the main standard solution having a concentration of 1000 mg/l by tenfold dilution. The instrument was calibrated at two points: 0 mg/l (pure tetrachloromethane) and 100 mg/l.

The solution to be analyzed (eluate) was introduced into a cuvette, placed in the instrument; a concentration was measured. The instrument readings were used for further calculations. If the concentration exceeded the upper limit of the range, the solution was multiply diluted with tetrachloromethane. The dilution was accounted for in subsequent calculations.

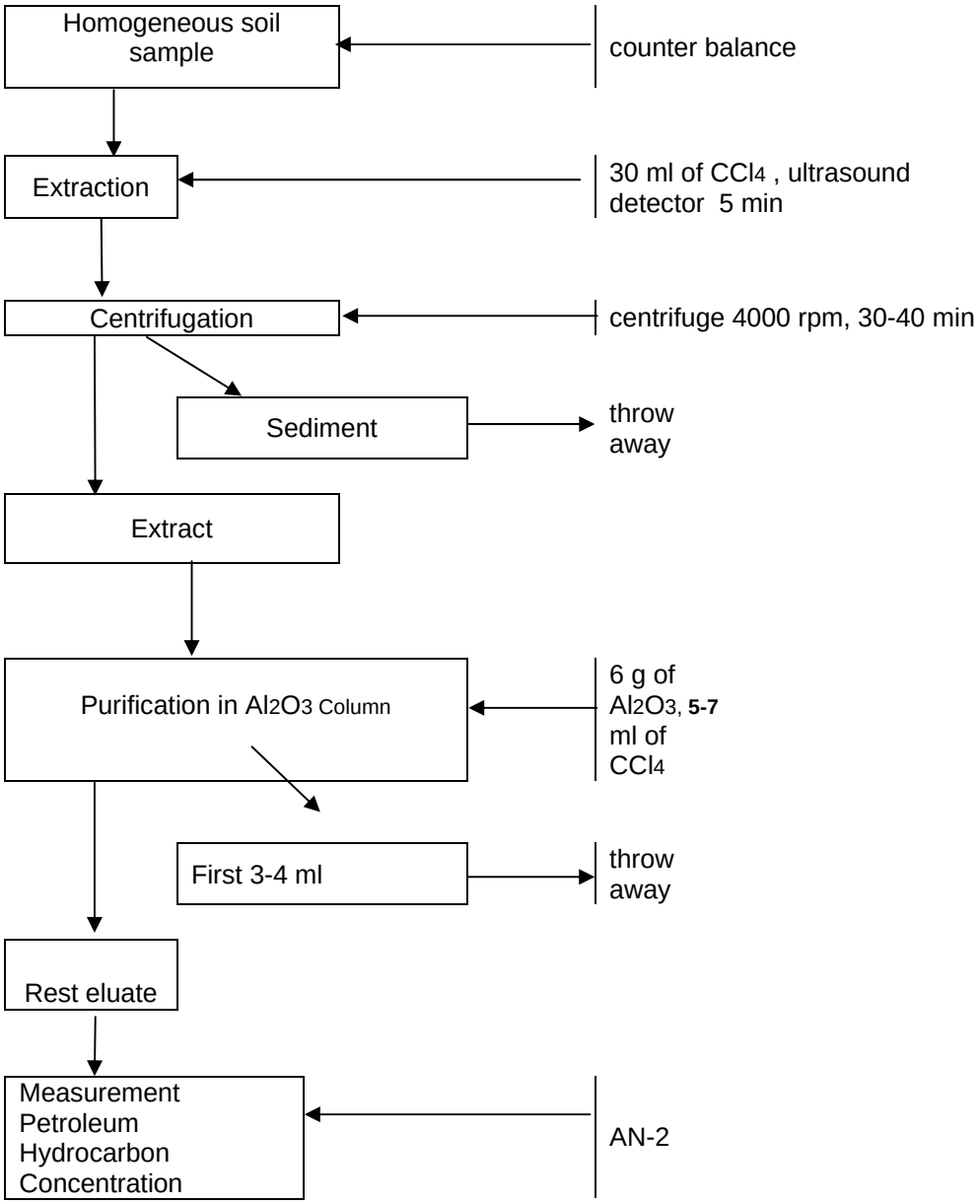


Figure 5.2-7 Soil analysis for petroleum hydrocarbons content scheme

Heavy metals

From a soil sample dried to a constant weight on a lyophilizer during 24 hours and milled in FRISTCH Pulverisette, a 1.00 g weigh with precision of 0.01 g was collected in a Teflon cup; then 3 cm^3 of full-strength perchloric acid, 3 cm^3 of full-strength nitric acid and 5 cm^3 of full-strength hydrofluoric acid were added. The mixture was capped and heated for an hour on an electric stove to (50±10) °C till the paste is formed, controlling the temperature with a digital thermometer.

The mixture was added with additional 5 cm^3 of full-strength nitric acid and 5 cm^3 of full-strength hydrofluoric acid and conditioned for an hour at a temperature of (90±10) °C. In an hour the temperature was raised to (160±10) °C; the mixture was evaporated to dryness, added with 2 cm^3 of full-strength nitric acid and 25 cm^3 of bidistilled water and boiled until the dissolution of sediments and about two-fold reduction in the volume.

Teflon membrane filters were successively washed with a solution of the hot hydrochloric acid (1:3), bidistilled water, solution of the hot nitric acid (1:3) and bidistilled water. A solution of the sample was filtered through a preliminary washed Teflon membrane filter to a 25 cm^3 measuring flask; bidistilled water was added until the solution reached a filling mark; then it was placed in a plastic flask.

For the measurement, the sample and matrix modifier (if necessary) were introduced into a graphite cuvette and atomized according to the operating manual of the spectrometer with electrothermal atomization. The atomization cycle and measurement of the analytical signal in the sample to be analyzed should be carried out at least two times. If the mass concentration measured exceeded the maximum mass concentration shown in the calibration chart, the sample was diluted with a 0.1N solution of nitric acid and the measurement was repeated.

To control sensitivity and stability of the calibration chart, the absorption of the calibration solution with the maximum mass concentration of the metal to be determined was measured after every 9 or 10 atomization cycles. If the result obtained differed from the value obtained during calibration by more than 10 percent, a recalibration was performed.

The conditions of heavy metal analysis are given in Table 5.2-6.

The determination of **mercury (Hg)** content was performed using the atomic absorption spectrophotometry method of acid digest of soil according to PNDF 16.1:2.3:3.10-98 Soils. Technique of measurement of mercury content in solid objects by atomic absorption spectrophotometry method (by cold vapor) similar in terms of analysis procedures to US EPA-7471A.

To determine mercury, a quick-unfrozen soil weigh of natural moisture was used; the soil moisture was determined in a parallel weigh.

To perform quantitative analysis, a spectrometer Kvant-Z-ETA with electrothermal atomization, Zeeman background correction system, GRG-106 cold vapor generator with accumulation on the cell surface modified by palladium

Table 5.2-6 Conditions of metal analysis

Metal	Wave length, nm	Slot width, nm	Buffer solution	
			Substance to modify	Mass concentration, percent
Cadmium	228.8	0.7	-	-
Cobalt	240.7	0.2	-	-
Chrome	357.9	0.7	NH_4Cl	2.0
Copper	324.8	0.7	-	-
Manganese	280.1	0.2	$CaCl_2$	0.4
Nickel	232.0	0.2	-	-
Lead	217.0	0.7	-	-
Zinc	213.9	0.7	-	-
Tin	286.3	0.7	$PdCl_2$	0.1
Mercury	253.7	0.7	-	-

Figure 5.2-8 Heavy metal analysis with the use of an atomic absorption spectrophotometer A-02

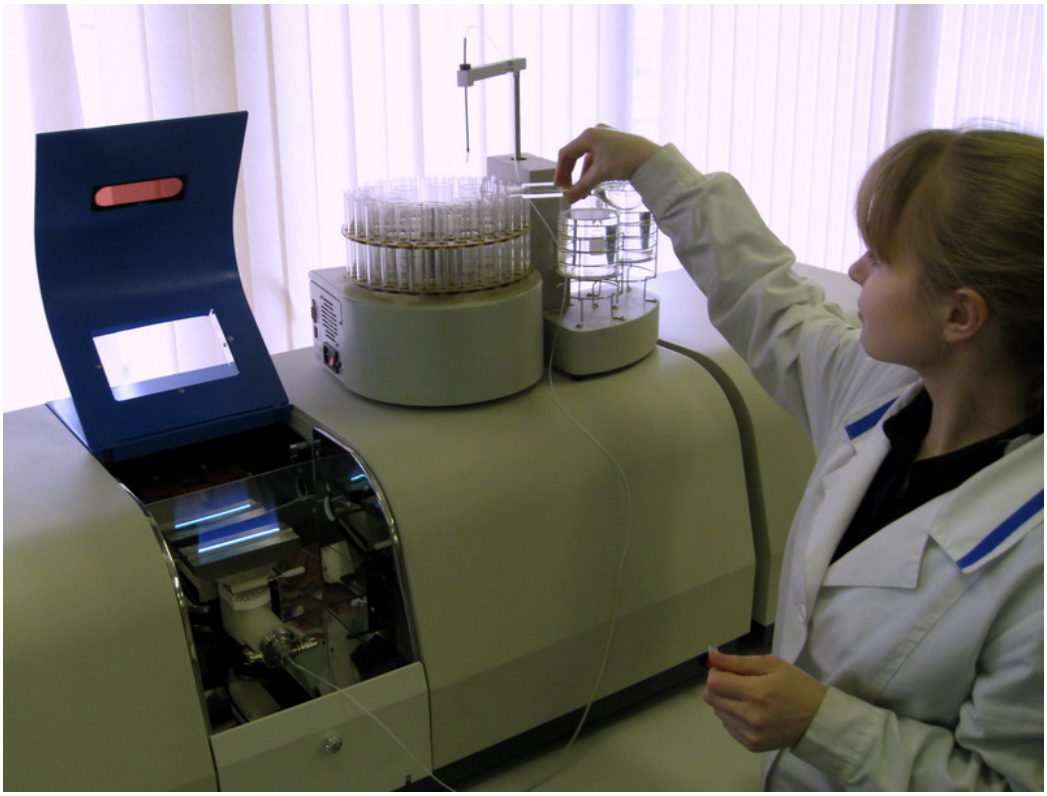


Figure 5.2-9 Atomic absorption spectrophotometer A-02

Figure 5.2-10 Ultrasonic extractor and other auxiliary equipment

Accuracy characteristics of soil analysis techniques

PCB detection limits in soils

Components	Detection limit, ng/g of dry weight
#28 - #209	0.05

Polychlorinated biphenyls (PCB):

Weight of the sample to be analyzed - 20 g
Final extract volume - 1000 mcl
Aliquot - 2 mcl
Error - 30 % for concentrations exceeding the detection limit by 3 times

Petroleum hydrocarbon and PAH detection limits in soils

Components	Detection limit, mcg/kg of dry weight
Petroleum hydrocarbons	2000
Naphthalene	2.0
Acenaphthylene	5.0
Fluorene	2.0
Acenaphtene	5.0
Phenanthrene	0.5
Anthracene	0.2
Fluoranthene	1.0
Pyrene	1.0
Benz(a)anthracene	0.1
Chrysene	0.3
Benz(b)fluoranthene	0.2
Benz(k)fluoranthene	0.1
Benza)pyrene	0.5
Dibenz(a,h)anthracene	0.5
Indeno(1,2,3-cd)pyrene	0.5
Benz(g,h,i)perylene	0.5

Petroleum hydrocarbons:

Weight of the sample to be analyzed - 20 g
Final extract volume - 30 ml
Error - 15 % for concentrations exceeding 4 mcg/g

Polycyclic aromatic hydrocarbons (PAH):

Weight of the sample to be analyzed - 10 g
Final extract volume - 1000 mcl
Aliquot - 50 mcl
Error - 15 % for concentrations exceeding the detection limit by 3 times

Heavy metal detection limits in soils

Components	Detection limit, mg/kg of dry weight
Manganese	0.02
Zinc	0.1
Copper	0.02
Nickel	0.03
Cobalt	0.02
Lead	0.03
Cadmium	0.005
Chrome	0.05
Tin	0.5
Mercury	0.003

Heavy metals (HM):

Weight of the sample to be analyzed – 0.3 g
Volume of the solution to be analyzed - 25 ml
Volume of the solution for mercury determination - 50 ml
Aliquot for mercury determination - 5 ml
Error - 25 % for concentrations exceeding the detection limit by 3 times

VAH detection limits in soils

Components	Detection limit, mg/kg of dry weight
Benzene	0.001
Toluene	0.001
O-cresol	0.001
M- and p-cresols	0.001
Ethylbenzene	0.001
Pseudocumene	0.001
Cumene	0.001

VAH:

Weight of the sample to be analyzed - 2 g
Volume of the solution to be analyzed - 10 ml
Aliquot for determination - 100 mcl of vapor
Error - 25 % for concentrations exceeding the detection limit by 3 times
Toluene

5.2.2 Description of the methods of technical liquid analysis

Preparation of technical liquid samples for PCB content analysis

A weighed portion of sample (2 grams) was put into a Teflon extraction test tube; 500 mcl of 100 ng/ml DBOFB mixture in methanol and 500 mcl of 100 ng/ml PCB#198 mixture in acetone were added; the test tube was sealed with a cap and mixed for 5 minutes on a vortex.

The samples were purified from sulfur compounds with saturated sodium sulfite solution in 50 percent isopropyl alcohol with tetrabutylammonium (TBA) hydrosulfate added as a phase-transfer catalyst. The final purification from sulfur compounds was carried out with the use of metallic activated copper in 0.1 mm powder form

Then the liquid solution was purified on a preparative column with Florisil modified with 1 percent of water; 100 ml of hexane and 100 ml of hexane/dichloromethane mixture (4:1) chlororganic compounds were eluted. The eluate was concentrated on the rotary evaporator up to 2 ml volume in hexane, put into a graduated test tube and evaporated to 1 ml with nitrogen gas; then the output control standard – 50 ng of naphthalene tetrachloride (TCN) was added to 10 mcl of hexane. A 10 ml aliquot was placed in the chromatograph

Measurements

Quantitative analysis of organochlorine compounds was performed using gas chromatography method with electron capture detector (ECD) similarly to soil extract analysis.

The degree of PCB extraction for all samples was from 44 to 72 percent. The degree of extraction was assessed using an extraction standard - naphthalene tetrachloride added to the sample immediately prior to their analysis.

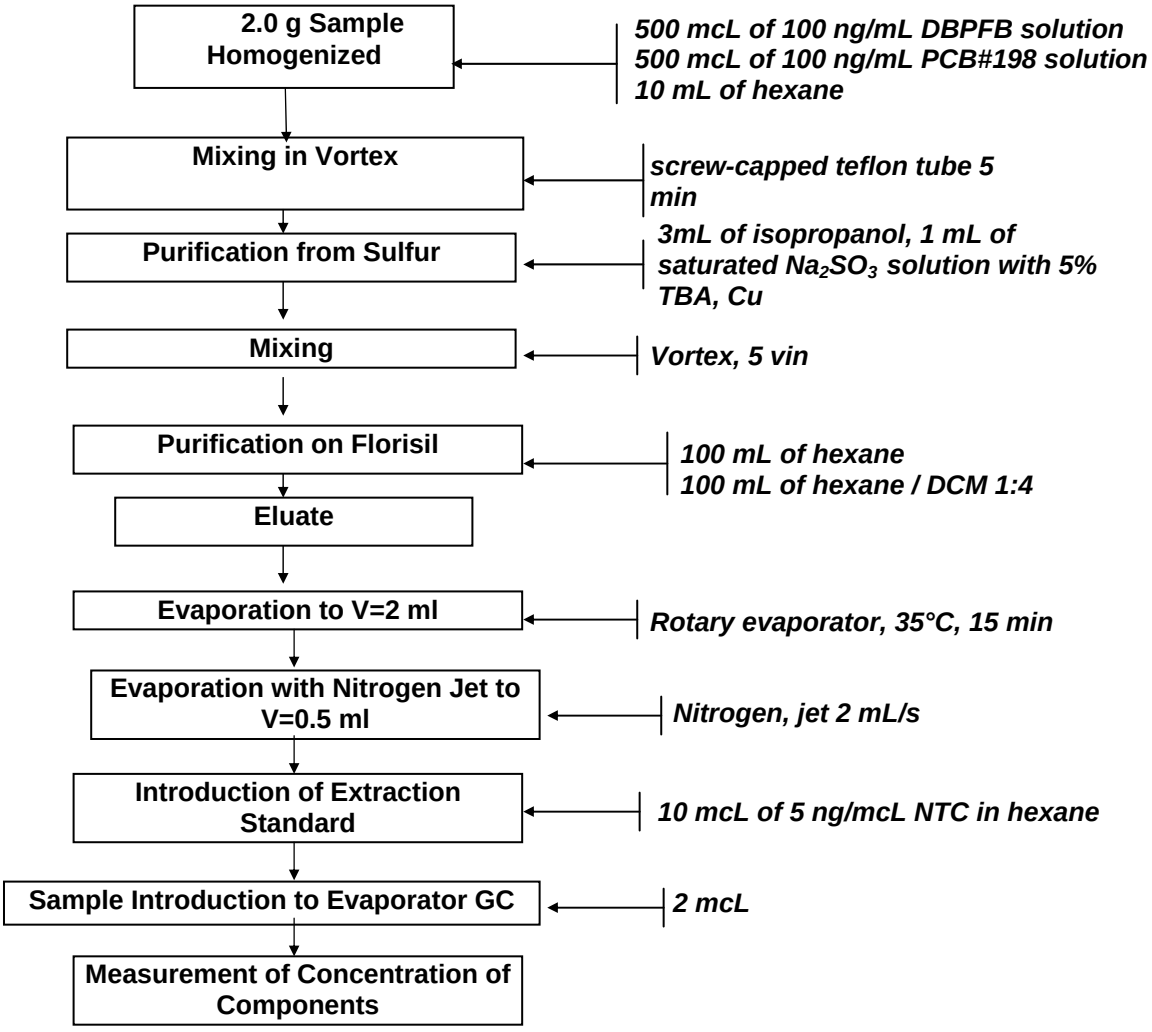


Figure 5.2-11 Technical liquid analysis for PCB content scheme

Description of the methods of technical liquid analysis by physical parameters

The **density** was determined according to GOST 3900-85 “Oil and oil products. Methods for determination of density” using a hydrometric method. The principle of the method is in the immersion of the hydrometer in the product to be tested, taking of readings from the hydrometer scale at the determination temperature and conversion of the results for the density at 20ºC. GOST 3900-85 for the measurement procedures corresponds to the International Standard ISO 3675:1998 (E).

In parallel, the density was determined with a vibration liquid density meter VIP-2M according to ISO 12185-1996 “Crude oil and oil products. Determination of density. Oscillating U-tube method”. The operating principle of the density meter is based on measuring the natural period of oscillations the density transmitter U-tube (measuring cell) filled with liquid to be measured. The density of the liquid filled is calculated from the measured value. For this purpose, the results of preliminary calibration of the density meter by two substances whose density is known. The density values obtained by the two methods were within the reproducibility limits of the both methods. The hydrometric method is arbitrary (GOST 3900-85).

The **viscosity** was determined according to GOST 33-2000 “Oil products. Transparent and opaque liquids. Determination of kinematic viscosity and calculation of dynamic viscosity”. The principle of the method is in the measurement using a graduated glass viscosity meter of the flow time (in seconds) of a certain volume of a liquid to be tested under the influence of gravity at a constant temperature.

The flash point was determined according to GOST 4333-87 “Oil products. Methods for determination of flash and ignition points in open cup”. The principle of the method is in the heating of an oil product sample in open cup at a preset rate until the oil product vapors flash (flash point) above its surface from an incendiary device. GOST 4333-87 for the measurement procedures corresponds to the International Standard ISO 2592-73.

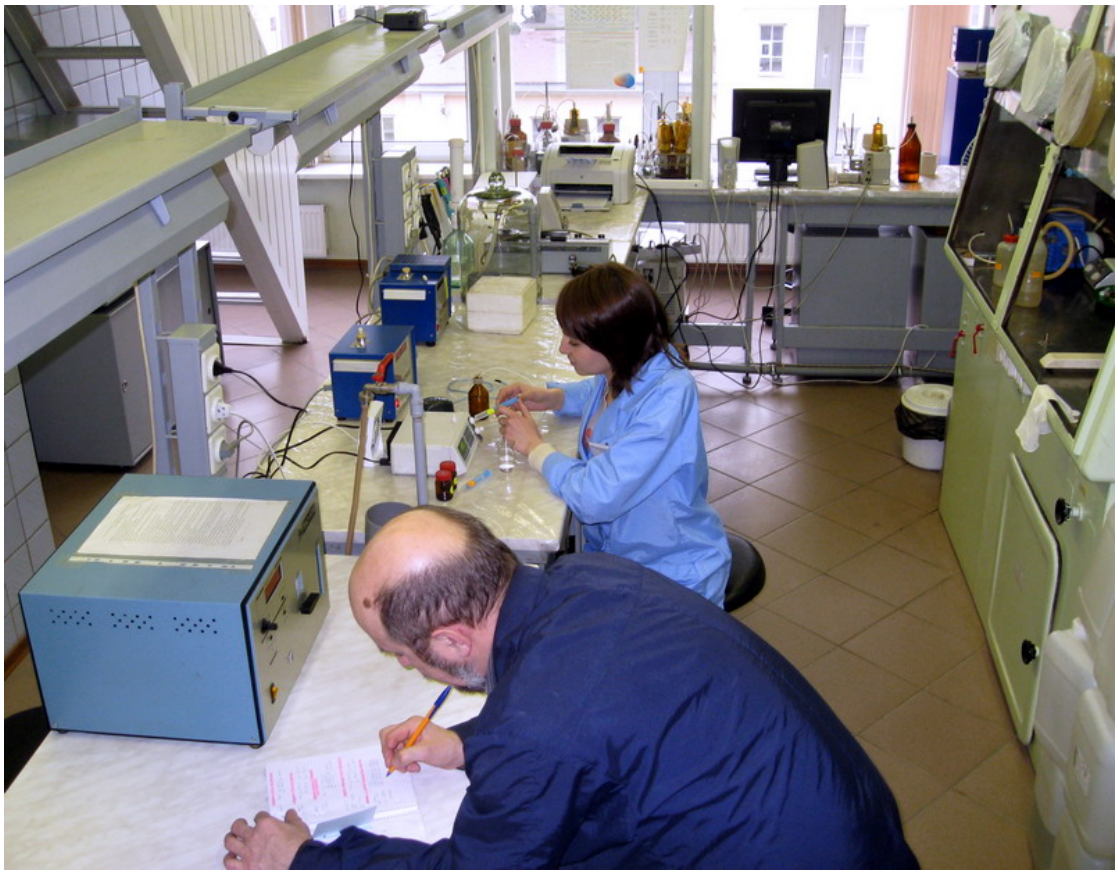


Figure 5.2-12

Figure 5.2-13
Workplaces in the Laboratory of analysis of oil product composition and properties

Figure 5.2-14 Digital density and viscosity meters for oil products

Quality control

Quality control of data obtained on the content of pollutants (petroleum hydrocarbons, VAH, PAH and heavy metals) included analysis of blank samples, standard solutions, duplicated specimens, specimens with the same matrix composition having a known content of target components and also control of calibration by standard solution of the compounds to be analyzed. Russian-made state standard samples were used as calibration standards; certified standard solutions made by the ULTRA Scientific (USA) were used to control the calibration

Quality control of data obtained on the content of PCBs in soils and technical liquids included the calibration of the chromatographic analytical system by standard solutions having an international certificate and a similar scope of work on the analysis of blank samples, standard solutions, specimens with the same matrix composition having a known content of target components and duplicated specimens of soils and technical liquids

The blank samples (field blank) were analyzed for the region of Alexandra Island – 2 pieces, for the region of Graham Bell Island – 2 pieces and for Hoffman Island – 1 piece; in addition, the analysis was performed of two blank samples for a series of technical liquids.

Certified standards made by the ULTRA Scientific (USA) and Russian-made state standard samples were used as calibration standards.

The specimens distributed within the QUASIMEME Program the composition of which had already been published were used as matrix specimens with a known content of target components.

Five soil samples and two technical liquid specimens were analyzed in three replications. The results of quality control of the data on the content of PCBs in soils and technical liquids are given in Table 5.2-7.

Table 5.2-7 Quality control during the determination of PCBs in soils and technical liquids, mcg/kg of dry weight

Sample Number	CB28	CB52	CB101	CB105	CB118	CB138	CB153	CB156	CB180
Blank L1 (Alexandra Island)	0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Blank L2 (Graham Bell Island)	0.02	0.02	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01
Soils:									
Blank (1- 14,79-89 Alexandra Island)	0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Blank (89- 110 Alexandra Island)	0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Blank (15- 38 Graham Bell Island)	0.02	0.03	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01
Blank (39 – 61 Graham Bell Island)	0.01	0.02	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01
Blank (62-78 Hoffman Island)	0.02	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
CRM 29 MS rated content.	1.16	0.56	1.33	0.55	1.51	2.67	2.62	0.30	1.40
CRM 29 MS detected	0.98	0.52	1.42	0.64	1.70	2.84	2.80	0.33	1.48
Liquid - L02-009-1	11.7	67.8	24.8	0.91	<0.05	56.1	2.87	3.21	8.21
Liquid - L02-009-2	12.3	69.1	24.3	0.84	<0.05	54.3	3.09	3.18	8.45
Liquid - L02-009-3	11.5	66.2	22.5	0.98	<0.05	59.6	2.97	3.48	9.09
Liquid - L09-013-1	17.5	27.8	8.2	<0.05	1.47	35.3	9.7	1.67	20.7
Liquid - L09-013-2	17.9	29.1	8.9	<0.05	1.56	36.5	9.2	1.58	22.0
Liquid - L09-013-3	17.2	28.4	8.0	<0.05	1.68	33.2	10.1	1.46	21.3
Soil - S06-063-1	1.41	4.02	10.9	2.79	6.60	12.7	8.86	1.00	0.56
Soil - S06-063-2	1.39	3.84	11.3	2.97	6.68	12.4	8.99	0.87	0.43
Soil - S06-063-3	1.52	4.21	10.3	2.64	6.24	13.1	8.24	0.96	0.64
Soil - S02-016-1	0.25	0.19	0.11	0.10	0.09	0.23	0.25	<0.05	<0.05
Soil - S02-016-2	0.28	0.14	0.12	0.08	0.12	0.28	0.27	<0.05	<0.05
Soil - S02-016-3	0.31	0.23	0.15	0.14	0.11	0.17	0.18	<0.05	<0.05
Soil - S04-050-1	0.58	1.61	1.26	0.36	0.37	1.45	1.21	0.21	0.18
Soil - S04-050-2	0.63	1.67	1.18	0.29	0.41	1.55	1.14	0.28	0.24
Soil - S04-050-3	0.49	1.48	1.22	0.34	0.32	1.36	1.42	0.19	0.14
Soil - S01-005-1	0.72	2.30	1.40	0.19	0.26	0.66	1.43	0.24	<0.05
Soil - S01-005-2	0.65	2.35	1.34	0.14	0.31	0.71	1.48	0.18	<0.05
Soil - S01-005-3	0.77	2.19	1.55	0.25	0.24	0.62	1.29	0.27	<0.05
Soil - S10-106-1	0.69	10.1	14.8	3.71	2.82	13.7	8.15	1.88	2.04
Soil - S10-106-2	0.77	12.0	15.6	4.04	2.67	14.6	7.54	1.65	2.35
Soil - S10-106-3	0.61	11.5	13.2	3.87	2.98	12.7	8.03	1.89	1.93

5.3 Evaluation of the level of soil contamination on the surveyed territory

During the evaluation of the level of pollutant content in soil, maximum permissible concentrations (MPC) and approximate permissible concentrations (APC), established by respective Russian regulatory documents; international criteria for environmental assessment of soil contamination according to Building Regulations SP 11-102-97 "Engineering environmental site investigations for construction" were used as standard values, as well as other regulatory documents:

- Health Standard 2.1.7.2041-06 Maximum permissible concentration (MPC) of chemicals in soil;
- Health Standard 2.1.7.2042-06 Approximate permissible concentration (APC) of chemicals in soil;
- International criteria for environmental assessment of soil contamination according to Neue Niederlandische Liste. Altlasten Spektrum 3/95; Building Regulations SP 11-102-97, Annex B

MPC and APC (according to the individual value or sum of compounds from a specific group) have been established by Russian regulatory documents for 22 soil quality indices for 49 pollutants to be monitored. Niederlandische Liste establish permissible concentrations (PC) and intervention level (IL) concentrations (according to the individual value or sum of compounds from a specific group) for 32 compounds. The values of standardized soil pollution indices are given in Table 5.3-1.

Table 5.3-1 Maximum permissible concentration (MPC), approximate permissible concentration (APC), levels of permissible concentrations (PC) and intervention levels (IL) of pollutants in soil according to Russian and foreign standards

Pollutant	Class of hazard	Standard according to Health Standard 2.1.7.2041-06, Health Standard 2.1.7.2042-06				Standards, established by Neue Niederlandische Liste. Altlasten Spektrum 3/95	
		MPC, mg/kg	APC for different types of soil, mg/kg			PC, mg/kg	IL, mg/kg
			Sandy and sandy-loam	Acidic (loam and clay), pH KCl<5,5	Close to neutral, neutral (loam and clay), pH KCl>5,5		
Oil products (total)						50	5000
Benzene	2	0.3				0.05	1
Toluene	2	0.3				0.5	130
Ethylbenzene						0.05	50
∑ meta- and para-Xylene	2	0.3					
Ortho-Xylene	2	0.3				0.5	25
Isopropylbenzene	1	0.5					
Benz(a)pyrene	1	0.02					
Total 10 PAHs						1	40
Total 7 PCBs	1	0.06 [1)]				0.02	1
Manganese [2)]	3	1500					
Zinc [2)]	1		55	110	220	140	720
Copper [2)]	2		33	66	132	36	190
Nickel [2)]	2		20	40	80	35	210
Cobalt [2)]	2					20	240
Lead [2)]	1	32	32	65	130	85	530
Cadmium [2)]	1		0.5	1.0	2.0	0.8	12
Chrome	2	6 [3)]				100	380
Mercury [2)]	1	2.1				0.3	10

Note: [1)] – according to Health Standard 1.1.546-96 Health standards of pesticides concentration in the environment. RF Gossanepidnadzor (Sanitary and Epidemiological Supervision) – Moscow: RF Ministry of Health, 1997;
[2)] – gross content;
[3)] – active form of Cr^{3+}.

Soil quality was assessed according to the requirements of SanPiN 2.1.7.1287-03 “Sanitary and epidemiological soil-quality requirements” and with account of MG 2.1.7.730-99 “Hygienic assessment of soil quality in the residential localities”.

The main criterion of sanitary chemical assessment of soil contamination is the maximum permissible concentration (MPC) or approximate permissible concentration (APC) of chemicals in soil.

The level of hazard of soil contamination with chemicals is assessed for each substance taking into account general regularities:

The more the actual content of soil contaminants exceeds MPC, the higher contamination hazard is.

- The more the actual content of soil contaminants exceeds MPC, the higher the contamination hazard is.
- The higher the class of hazard of a substance to be monitored, its persistency, solubility in water and mobility in soil and thickness of contaminated layer, the higher the contamination hazard is.
- The less soil buffer power, the higher the contamination hazard is.

When soil is contaminated with one inorganic substance, the contamination level is assessed according to Table 5.3-2 taking into account the class of hazard of the contaminant, its MPC and the

maximum value of permissible level of the element content Kmax by one of the four nuisance values.

When soil is contaminated with one organic substance, its hazard is determined by its MPC and class of hazard (Table 5.3-2).

Table 5.3-2 Assessment of the level of soil chemical contamination

Contamination class	Khlebnikov's sanitary index	Total Soil Pollution Index (Zc)	Content in soil (mg/kg)					
			Class of hazard I		Class of hazard II		Class of hazard III	
			Organic compounds	Inorganic compounds	Organic compounds	Inorganic compounds	Organic compounds	Inorganic compounds
Clean *	0.98 and >	-	from background to MPC	from background to MPC	from background to MPC	from background to MPC	from background to MPC	from background to MPC
Permissible	0.98 and >	<16	from 1 to 2 MPC	from 2 background values to MPC	from 1 to 2 MPC	from 2 background values to MPC	from 1 to 2 MPC	from 2 background values to MPC
Moderately hazardous	0.85-0.98	16-32					from 2 to 5 MPC	from MPC to C max
Hazardous	0.7-0.85	32-128	from 2 to 5 MPC	from MPC to C max	from 2 to 5 MPC	from MPC to C max	> 5 MPC	> C max
Extra hazardous	<0.7	>128	>5 MPC	>C max	>5 MPC	>C max		

Note: Cmax – the maximum value of permissible level of the element content by one of the four nuisance values.
* Contamination class is related to higher risk.
Zc – calculated according to methodological guidelines for hygienic assessment of soil quality in the residential localities.

In case of contamination with several elements, soil contamination hazard level can be assessed for the most toxic element whose content in soil is the highest.

The level of soil contamination as an indicator of adverse impact on human health is assessed by indices developed in the course of complementary geochemical and geohygienic environmental studies of the localities with active contamination sources. These indices are as follows: chemical concentration ratio (Cc). Cc is determined by a ratio of the actual content of the chemical to be determined in soil (Ci) in mg/kg of soil to the regional background value (Cbi):

$$Cc = Ci/ Cbi;$$

and *total pollution index* (Zc). The total pollution index is equal to a sum of the ratios of concentrations of chemical contaminants and can be expressed by a formula

$$Zc = \sum (Cci + \ldots + Ccn) - (n-1),$$

where n is a number of summed substances to be determined;
Cci is a concentration ratio of contaminant i.

The level of soil contamination with a series of metals by index Zc is assessed through the use of a rating scale given in Table 5.3-3.

Table 5.3-3 Approximate rating scale of soil contamination hazard by total pollution index (Zc)

Soil contamination class	Value of Zc	Changes in health indices in pollution focuses
Permissible	Less than 16	The lowest morbidity level among children and minimum frequency of functional deviations
Moderately hazardous	16-32	Increase in general morbidity
Hazardous	32-128	Increase in general morbidity, number of sickly children, children suffering chronic diseases and decline in cardiovascular fitness
Extra hazardous	More than 128	Increase in children morbidity, disturbances of female reproductive function (increase in toxemia of pregnancy, number of premature births, stillbirth rate and small for gestational age babies)

The total pollution index Zc was calculated by 9 contamination parameters: manganese, zinc, copper, nickel, cobalt, lead, cadmium, chrome and mercury. The concentrations of heavy metals in the Far North regions (Taimyr Peninsula and Spitsbergen Archipelago) were used as background values.

Table 5.3-4 Heavy metal backgrounds for the Far North regions

Element	Background, mg/kg
Manganese	106.72
Zinc	24.9
Copper	8.3
Nickel	6.5
Cobalt	5.0

Element	Background, mg/kg
Lead	8.8
Cadmium	0.1
Chrome	7.54
Mercury	0.1

The assessment using international standards was performed on the basis of the comparison of the values obtained of the content of the indices to be monitored with the PC and IL values.
Taking into consideration that any MPC (APC) Russian standard for oil product content in soil does not exist, the PC Niederlandische Liste standard was used to assess the level of contamination with petroleum hydrocarbons.
Table 5.3-5 shows the characteristics of the type of soils to be analyzed and visual indicators of contamination.

Table 5.3-5 Description of soils by the samples collected at the surveyed areas on Franz Josef Land islands

Point number	Type of soil	Indicators of contamination
Alexandra Island		
S01-001	rubble-loam	significant inclusions of refuse wood, visual contamination with oil products
S01-002	rubble-clay	weak smell of oil products, visual contamination with oil products
S01-003	rubble-loam	strong smell of oil products; visual contamination with oil products, inclusions of refuse wood
S01-004	rubble-clay	strong smell of oil products, visual contamination with oil products
S01-005	loam	strong smell of oil products, visual contamination with oil

		products
S01-006	man-made soil (construction waste)	smell of oil products, visual contamination with oil products
S01-007	rubble-clay	smell of oil products, visual contamination with oil products
S01-008	loam	weak smell of oil products
S01-009	rubble-sand loam	very weak smell of oil products
S01-010	loam	weak smell of oil products
S01-011	loam	strong smell of oil products, visual contamination with oil products
S01-012	man-made soil (construction waste)	smell of oil products, visual contamination with oil products
S01-013	rubble-clay	not very strong smell of oil products
S09-79	loamy sand	no smell
S09-80	loamy sand	weak smell of oil products
S09-81	loamy sand	strong smell of oil products, visual contamination with oil products
S09-82	rubble	not very strong smell of oil products, visual contamination with oil products
S09-83	loamy sand	strong smell of oil products, visual contamination with oil products
S09-84	man-made soil (construction waste)	weak smell of oil products, visual contamination with oil products
S09-85	sand	strong smell of oil products, visual contamination with oil products
S09-86	man-made soil (construction waste)	strong smell of oil products
S09-87	rubble-clay	smell of oil products, visual contamination with oil products
S09-88	rubble-sand loam	very strong smell of oil products, visual contamination with oil products
S09-89	loam	strong smell of oil products, visual contamination with oil products
S09-90	rubble-loam	strong smell of oil products, visual contamination with oil products
S09-91	sand	very strong smell of oil products, visual contamination with oil products
S09-92	sand	strong smell of oil products, visual contamination with oil products
S09-93	sand	strong smell of oil products, visual contamination with oil products
S09-94	sand	strong smell of oil products, visual contamination with oil products
S09-95	rubble-clay	smell of hot asphalt, visual contamination with oil products

Continuation of Table 5.3-5

Point number	Type of soil	Indicators of contamination
Alexandra Island		
S09-96	rubble-clay	very strong smell of oil products, visual contamination with oil products
S09-97	rubble-sand loam	very strong smell of oil products, visual contamination with oil products
S09-98	rubble-sand loam	smell of oil products, visual contamination with oil products
S09-99	rubble-loam	very strong smell of oil products, visual contamination with oil products
S09-100	rubble-loam	weak smell of oil products, visual contamination with oil products
S09-101	rubble-loam	strong smell of oil products
S09-102	rubble-loam	smell of oil products, visual contamination with oil products
S10-103	loamy sand	no smell
S01-014	loamy sand	no smell
S10-104	loamy sand	weak smell of oil products
S10-105	loamy sand	weak smell of oil products
S10-106	loamy sand	no smell
S10-107	loamy sand	smell of burning
S10-108	clay	no smell
S10-109	clay	weak smell of oil products
S10-110	clay	no smell
Hoffman Island		
S06-062	clay	no smell, significant inclusions of refuse wood
S06-063	clay	weak smell of oil products
S06-064	clay	weak smell of oil products, visual contamination with oil products
S06-065	clay	weak smell of oil products
S06-066	clay	weak smell of oil products, visual contamination with oil products
S06-067	clay	no smell
S06-068	clay	no smell
S06-069	loamy sand	no smell
S06-070	clay	strong smell, visual contamination with oil products
S06-071	clay	weak smell of oil products, visual contamination with oil products
S07-072	rubble-clay (very icy soil)	weak smell of oil products
S07-073	rubble-clay (very icy soil)	weak smell of oil products
S07-074	rubble-loam	significant inclusions of refuse wood
S07-075	loam	weak smell of oil products, visual contamination with oil products, significant inclusions of refuse wood
S07-076	rubble-clay (very icy soil)	smell of oil products
S07-077	rubble-loam	smell of oil products
S08-078	rubble-clay (very icy soil)	weak smell of oil products

Continuation of Table 5.3-5

Point number	Type of soil	Indicators of contamination
Graham Bell Island		
S02-015	sand	cadaverous smell
S02-016	sand	weak smell of oil products
S02-017	sand	no smell
S02-018	sand	no smell
S02-019	sand	no smell, inclusions of refuse wood
S02-020	loamy sand	no smell, inclusions of refuse wood
S02-021	sand	weak smell of oil products, inclusions of refuse wood
S02-022	sand	weak smell of oil products
S02-023	sand	no smell
S02-024	sand	strong smell of oil products, visual contamination with oil products
S02-025	sand	strong smell of oil products, visual contamination with oil products
S02-026	sand	no smell
S02-027	loamy sand	no smell
S02-028	man-made soil (construction waste)	no smell
S02-029	sand	no smell
S02-030	sand	no smell
S02-031	sand	weak smell of oil products
S02-032	sand	no smell
S02-033	sand	no smell
S02-034	loamy sand	smell of oil products
S03-035	sand	no smell
S03-037	sand	weak smell of oil products
S03-038	sand	no smell
S03-039	sand	no smell, inclusions of refuse wood
S03-040	sand	weak smell of oil products, inclusions of refuse wood
S03-041	sand	no smell
S03-042	sand	smell of oil products
S03-043	sand	smell of oil products
S04-044	clay	no smell
S04-045	sand	no smell
S04-046	loamy sand	weak smell of oil products, visual contamination with oil products
S04-047	loamy sand	no smell
S04-048	rubble-clay	strong smell of oil products, visual contamination with oil products, inclusions of refuse wood
S04-049	clay	weak smell of oil products
S04-050	loamy sand	weak smell of oil products
S04-051	clay	strong smell of oil products, visual contamination with oil products
S04-052	sand	no smell
S04-053	loam	no smell
S04-054	sand	weak smell of oil products

Continuation of Table 5.3-5

Point number	Type of soil	Indicators of contamination
Graham Bell Island		
S04-055	sand	cadaverous smell, visual contamination with oil products
S04-056	sand	no smell
S04-057	sand	no smell
S04-058	rubble-clay	strong smell of oil products, visual contamination with oil products
S05-059	sand	no smell
S05-060	sand	weak smell of oil products
S05-061	sand	no smell

5.3.1 Alexandra Island

5.3.1.1 Radar station and fuel and lubricant storage facility near the settlement of Nagurskoe (sites 9 and 10)

125 soil samples at 25 points of geocological testing were collected **at site 9 on Alexandra Island (radar station)**

Assessment according to Russian standards

The content of VAH compounds in soils at the site did not exceed tenths of MPC and amounted to:

- benzene - 0.003 mg/kg (up to 0.01 MPC units),
- toluene - 0.025 mg/kg (up to 0.08 MPC units)
- ∑ meta- and para-xylene - 0.029 mg/kg (up to 0.10 MPC units),
- ortho-xylene - 0.025 mg/kg (up to 0.08 MPC units),
- isopropylbenzene - 0.007 mg/kg (up to 0.01 MPC units).

The content of benz(a)pyrene amounted to 0.1785 mg/kg (up to8.9 MPC units, point S09-090).

The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents.

The content of heavy metals reached:

- manganese - 183.2 mg/kg (up to 0.1 MPC units, point S09-086);
- zinc - 232 mg/kg (up to 8.9 APC units, point S09-082);
- copper - 94.5 mg/kg (up to 1.6 APC units, point S09-085);
- nickel - 15.9 mg/kg (up to 2.52 APC units, point S09-088);
- lead - 161.7 mg/kg (up to 5.05 MPC units, point S09-082);
- chrome (mobile form) - 9.9 mg/kg (up to 1.65 MPC units, point S09-101);
- cadmium - 0.75 mg/kg (up to 1.00 APC units, point S10-103);
- mercury - 0.728 mg/kg (up to 0.35 MPC units, point S10-103).

The total PCB content reached up to 0.245 mg/kg (up to 4 APC units, point S09-082).

Intervals of pollutant content in soils at site's 9 points of geocological testing in mass concentration values and MPC, APC and PC units are given in Table 5.3-7 at the end of the Section.

Table 5.3-6 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards.

Table 5.3-6 Assessment of the levels of soil contamination at the radar station area (site 9) according to SanPiN 2.1.7.1287-03 and international standards

Index	Site 9									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	18134							2.34	**1068.8***	**362.67***
Benzene	0.002	0.00	0.01	0.00	permissible	permissible	permissible	0.00	0.07	0.03
Toluene	0.012	0.00	0.08	0.04	permissible	permissible	permissible	0.00	0.05	0.02
Ethylbenzene	0.004					permissible	permissible	0.00	0.19	0.09
∑ meta- and para-Xylene	0.012	0.00	0.10	0.04	permissible	permissible	permissible	0.00	0.06	0.02
Ortho-Xylene	0.010	0.00	0.08	0.03	permissible	permissible	permissible	0.00	0.05	0.02
Isopropylbenzene	0.003	0.00	0.01	0.01	permissible	permissible	permissible			
Benz(a)pyrene	0.0423	0.03	8.93	2.12	permissible	extra-hazardous	hazardous			
Total 10 PAHs	1.7264							0.06	8.11	1.73
Total 7 PCBs	0.051	0.04	4.08	0.85	permissible	hazardous	permissible	0.11	12.23	2.54
Manganese	70.1	0.01	0.12	0.05	permissible	permissible	permissible			
Zinc	58.6	0.06	140.0	28.48	permissible	extra-hazardous	extra-hazardous	0.09	1.66	0.42
Copper	47.4	0.10	36.00	8.35	permissible	extra-hazardous	extra-hazardous	0.36	2.63	1.32
Nickel	6.8	0.03	35.00	8.32	permissible	extra-hazardous	extra-hazardous	0.06	0.45	0.20
Cobalt	4.4							0.06	0.44	0.22
Lead	31.7	0.00	5.05	0.99	permissible	extra-hazardous	permissible	0.00	1.90	0.37
Cadmium	0.16	0.00	1.50	0.70	permissible	extra-hazardous	permissible	0.03	0.94	0.20
Chrome	5.2	0.28	1.65	0.87	permissible	extra-hazardous	permissible	0.02	0.10	0.05
Mercury	<0.003	0.728	0.058	0.00	permissible	permissible	permissible	0.00	2.43	0.19
Zc metals	9.15						permissible			

Note: * - values exceed the intervention level (IL)

In terms of the average content of volatile aromatic hydrocarbons, the total PCB, manganese, lead, cadmium, chrome and mercury, site's 9 soil belong to the **permissible** contamination class; in terms of the average content of **benz(a)pyrene** – to the **hazardous** contamination class; in terms of the content of **zinc, copper** and **nickel –** to the **extra-hazardous** contamination class.

The values of the total soil pollution index Zc calculated for a series of metals varied from 1.99 (**permissible** contamination class) to 28.62 (**moderately hazardous** contamination class), while the average value for the site was 9.15 (**permissible** contamination class).

At the same time, at all testing points (except for S09-101), in part of samples, the MPC or APC for zinc, copper, nickel, lead, chrome and cadmium and Kmax values (according to Methodological Guidelines 2.1.7.730-99) were exceeded to correspond toto the **extra-hazardous** soil contamination class.

In general, the level of soil contamination at the surveyed area of the radar station can be assessed as **extra-hazardous**.

Assessment according to international standards

Permissible concentrations (PC) of oil products, total PAHs, total PCBs, zinc, copper, lead and mercury were exceeded in the site's soils at separate points, including:

- oil products - up to 1068.8 PC units;
- total PAHs - up to 8.11 PC units;
- total PCBs – up to 12.23 PC units;
- zinc - up to 1.66 PC units;
- copper - up to 2.63 PC units;
- lead - up to 1.90 PC units;
- mercury - up to 2.43 PC units.

In general, the average content of pollutants for the site exceeds the PC values as follows: oil products – 362 times; total PAHs – 1.7 times, total PCBs – 2.5 times and copper – 1.3 times.

It is necessary to pay special attention to the fact that the level of soil contamination with oil products at the site **exceeds the intervention level** both in the average value (3.6 times) and in the values at separate points of geocological testing (up to 10 IL).

Figures 5.3-1 - 5.3-4 show spatial characteristics of the level of site's 9 soil contamination with oil products, total PAHs, total PCBs in PC units and integrated pollution with heavy metals in Zc units.

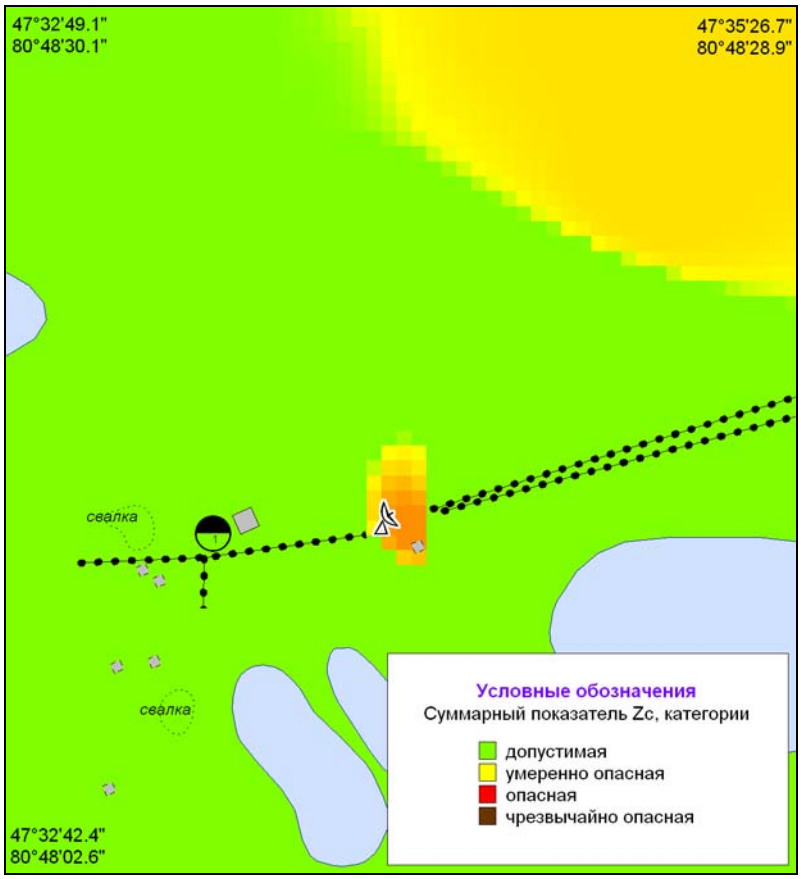


Figure 5.3-1 Spatial characteristics of the level of soil contamination of the radar station area (site 9) with a series of heavy metals (Zc)

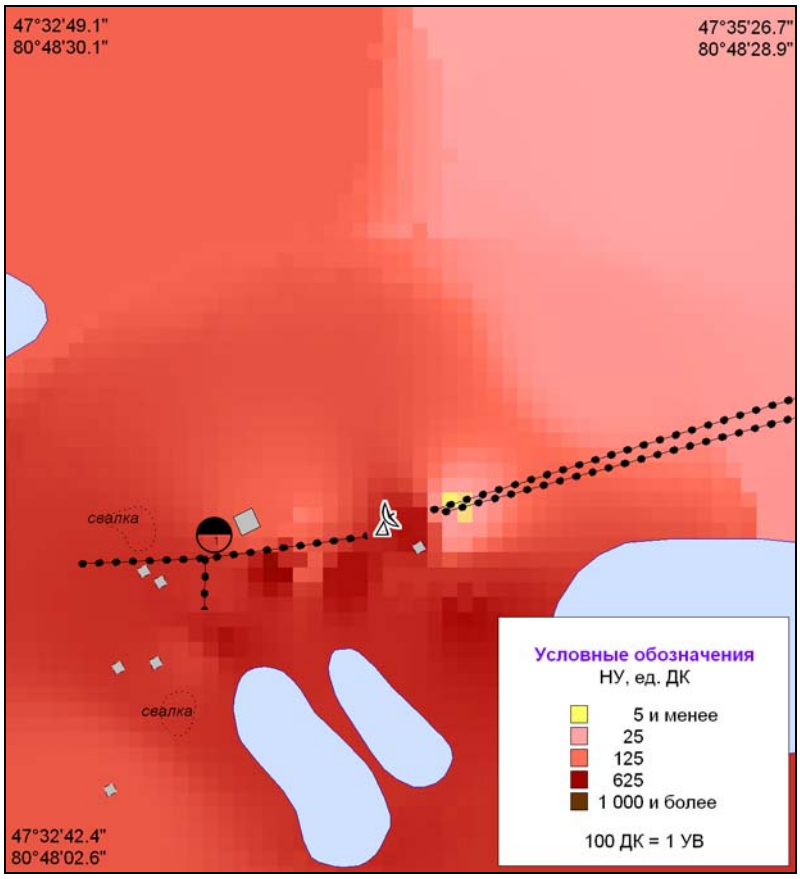
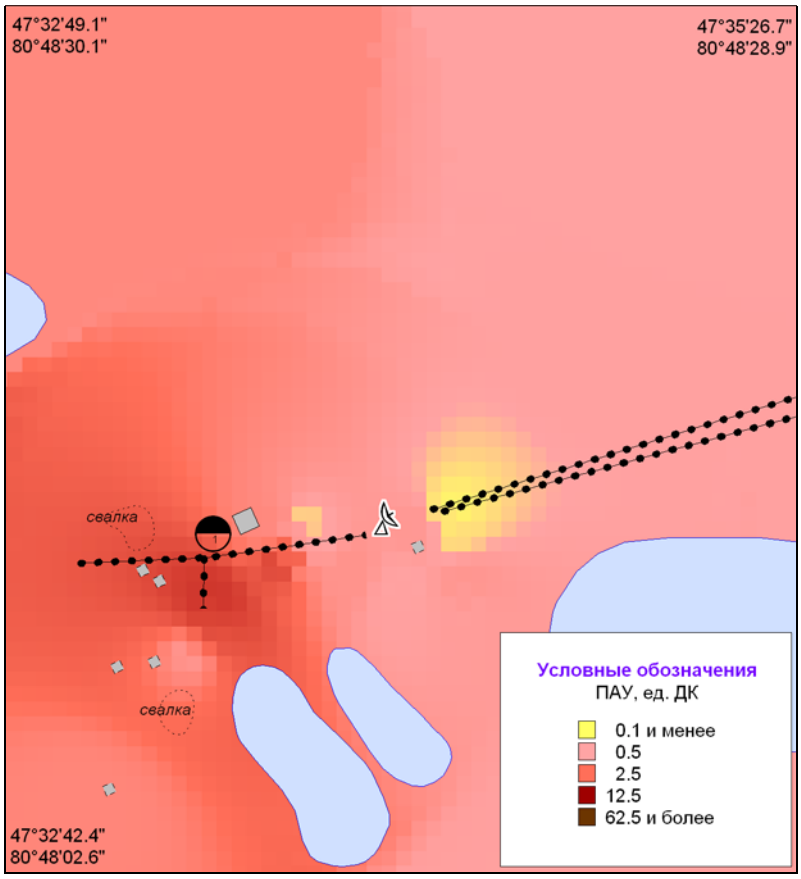
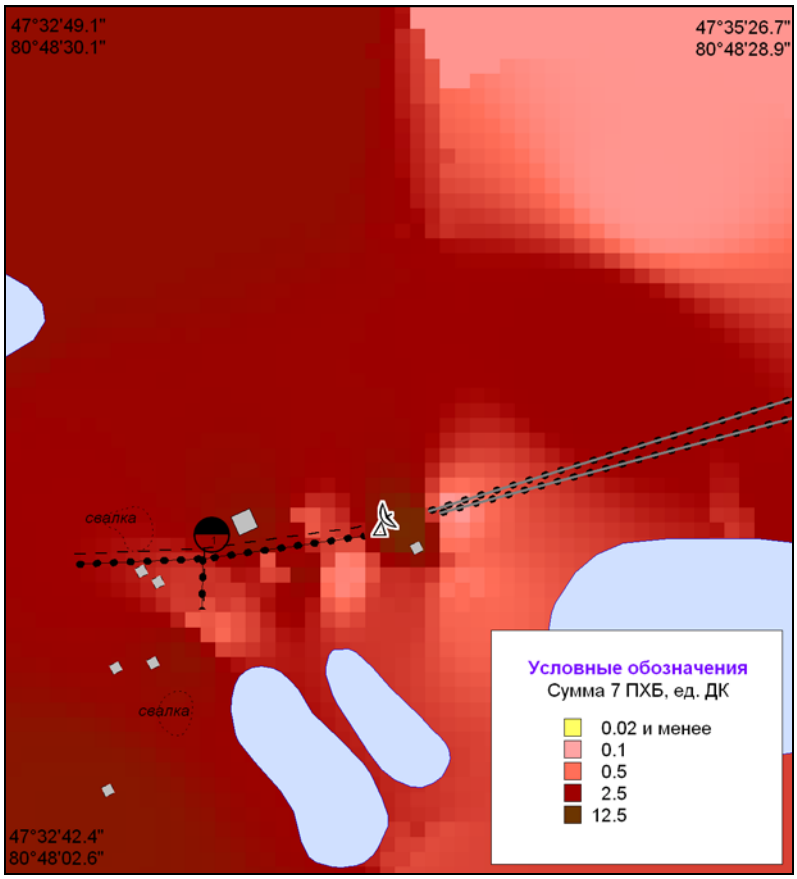


Figure 5.3-2 Spatial characteristics of the level of soil contamination of the radar station area (site 9) with petroleum hydrocarbons (oil products)



Note: Total 10 PAHs - anthracene, benz(a)anthracene, benz(k)fluoranthene, benz(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(123cd)pyrene, naphthalene, benz(ghi)perylene)

Figure 5.3-3 Spatial characteristics of the level of soil contamination of the radar station area (site 9) with polycyclic aromatic hydrocarbons



Note: Total 7 PCB - #28, #52, #101, #118, #138, #153, #180

Figure 5.3-4 Spatial characteristics of the level of soil contamination of the radar station area (site 9) with polychlorinated biphenyls

Table 5.3-7 Content of pollutants in the intervals of mass concentration and MPC, APC and PC units in soils at site's 9 points

Index	Point number											
	S09-079						S09-080					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	117	290	182	2.34*	5.80*	3.64*	2284	3190	2659	45.68*	63.80*	53.18*
Benzene	0.001	0.001	0.001	0.00	0.00	0.00	0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.001	0.002	0.002	0.00	0.01	0.01	0.001	0.002	0.002	0.00	0.01	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0041	0.0063	0.0051	0.21	0.32	0.26	0.0005	0.0008	0.0006	0.03	0.04	0.03
Total 10 PAHs	0.1067	0.1768	0.1428	0.11*	0.18*	0.14*	0.2231	0.2858	0.2539	0.22*	0.29*	0.25*
Total 7 PCBs	0.002	0.003	0.002	0.04	0.04	0.04	0.006	0.007	0.006	0.10	0.12	0.11
Manganese	88.0	123.0	110.2	0.06	0.08	0.07	28.5	61.2	43.8	0.02	0.04	0.03
Zinc	24.1	37.2	32.9	0.44	0.68	0.60	37.5	99.6	70.5	0.68	1.81	1.28
Copper	27.5	42.6	34.3	0.83	1.29	1.04	23.8	44	34.1	0.72	1.33	1.03
Nickel	6.2	8.8	7.3	0.31	0.44	0.37	4.0	9.0	6.6	0.20	0.45	0.33
Cobalt	2.2	5.1	3.3	0.11*	0.26*	0.17*	2.3	3.2	2.8	0.12*	0.16*	0.14*
Lead	<0.2	1.2	0.5	0.00	0.04	0.02	24.9	58.5	48.0	0.78	1.83	1.50
Cadmium	0.02	0.27	0.11	0.04	0.54	0.22	0.25	0.46	0.39	0.51	0.91	0.77
Chrome	2.2	5.1	3.5	0.37	0.85	0.58	2.8	7.4	6.0	0.47	1.23	1.00
Mercury	0.003	0.010	0.008	0.00	0.00	0.00	0.069	0.091	0.082	0.03	0.04	0.04

Index	Point number											
	S09-081						S09-082					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	37075	53440	45991	741.50*	1068.80*	919.82*	6078	10364	8728	121.56*	207.28*	174.56*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.007	0.010	0.009	0.02	0.03	0.03	0.008	0.011	0.009	0.03	0.04	0.03
Ethylbenzene	0.003	0.005	0.005	0.06*	0.11*	0.09*	0.002	0.004	0.004	0.04*	0.09*	0.07*
∑ meta- and para-Xylene	0.008	0.012	0.011	0.03	0.04	0.03	0.010	0.013	0.011	0.03	0.04	0.04
Ortho-Xylene	0.002	0.004	0.003	0.01	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Isopropylbenzene	0.002	0.004	0.003	0.00	0.01	0.01	0.002	0.003	0.003	0.00	0.01	0.01
Benz(a)pyrene	0.0143	0.0222	0.0178	0.72	1.11	0.89	0.0205	0.0398	0.0322	1.03	1.99	1.61
Total 10 PAHs	0.8861	1.0855	0.9612	0.89*	1.09*	0.96*	0.8343	1.0747	0.9419	0.83*	1.07*	0.94*
Total 7 PCBs	0.182	0.217	0.203	3.03	3.62	3.39	0.186	0.245	0.213	3.10	4.08	3.55
Manganese	42.6	81.2	59.3	0.03	0.05	0.04	31.0	65.3	48.1	0.02	0.04	0.03
Zinc	123.0	175	151.0	2.24	3.18	2.75	124.8	232	202.7	2.27	4.22	3.69
Copper	41.7	52.3	46.0	1.26	1.58	1.39	33.1	64	44.7	1.00	1.94	1.35
Nickel	5.2	7.1	6.1	0.26	0.36	0.31	5.3	10.8	8.3	0.27	0.54	0.41
Cobalt	1.2	3.4	2.0	0.06*	0.17*	0.10*	3.7	5.3	4.2	0.19*	0.27*	0.21
Lead	50.8	93.5	71.5	1.59	2.92	2.23	108.4	161.7	141.9	3.39	5.05	4.43
Cadmium	0.07	0.40	0.23	0.14	0.80	0.47	0.24	0.34	0.29	0.48	0.67	0.57
Chrome	3.8	5.5	4.4	0.63	0.92	0.73	2.2	3.4	2.8	0.37	0.57	0.47
Mercury	0.050	0.180	0.098	0.02	0.09	0.05	0.102	0.135	0.118	0.05	0.06	0.06

Continuation of Table 5.3-7

Index	Point number											
	S09-083						S09-084					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	2466	4231	3411	49.32*	84.62*	68.22*	3715	7301	5635	74.30*	146.02*	112.71*
Benzene	0.001	0.002	0.001	0.00	0.01	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.007	0.010	0.008	0.02	0.03	0.03	0.006	0.013	0.011	0.02	0.04	0.04
Ethylbenzene	0.003	0.008	0.006	0.07*	0.15*	0.12*	0.002	0.004	0.003	0.04*	0.07*	0.06*
∑ meta- and para-Xylene	0.011	0.019	0.016	0.04	0.06	0.05	0.007	0.016	0.012	0.02	0.05	0.04
Ortho-Xylene	0.002	0.004	0.003	0.01	0.01	0.01	0.002	0.003	0.003	0.01	0.01	0.01
Isopropylbenzene	0.003	0.004	0.004	0.01	0.01	0.01	0.003	0.004	0.004	0.01	0.01	0.01
Benz(a)pyrene	0.0017	0.0028	0.0023	0.09	0.14	0.11	0.0586	0.0755	0.0648	2.93	3.78	3.24
Total 10 PAHs	0.0627	0.0921	0.0785	0.06*	0.09*	0.08*	0.9409	1.2638	1.1600	0.94*	1.26*	1.16*
Total 7 PCBs	0.005	0.006	0.005	0.09	0.10	0.09	0.111	0.132	0.126	1.86	2.21	2.09
Manganese	55.5	106.3	90.0	0.04	0.07	0.06	44.7	86.1	68.0	0.03	0.06	0.05
Zinc	68.3	120.3	89.3	1.24	2.19	1.62	25.6	56.1	42.8	0.47	1.02	0.78
Copper	36.8	79.0	57.0	1.12	2.39	1.73	41.8	68.0	54.5	1.27	2.06	1.65
Nickel	4.5	9.9	6.9	0.23	0.50	0.35	3.1	6.3	4.9	0.16	0.32	0.24
Cobalt	2.2	3.0	2.5	0.11*	0.15*	0.13*	1.5	2.0	1.8	0.08*	0.10*	0.09*
Lead	43.7	75.8	63.2	1.37	2.37	1.98	33.1	59.7	47.2	1.03	1.87	1.48
Cadmium	0.03	0.05	0.04	0.07	0.10	0.09	0.05	0.11	0.09	0.10	0.21	0.17
Chrome	3.5	6.0	5.0	0.58	1.00	0.83	3.2	5.6	4.6	0.53	0.93	0.77
Mercury	0.211	0.279	0.236	0.10	0.13	0.11	0.008	0.011	0.009	0.00	0.01	0.00

Index	Point number											
	S09-085						S09-086					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	6365	11222	9287	127.30*	224.44*	185.75*	5891	10359	8671	117.82*	207.18*	173.42*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.001	0.002	0.001	0.00	0.01	0.00
Toluene	0.004	0.008	0.006	0.01	0.03	0.02	0.004	0.008	0.006	0.01	0.03	0.02
Ethylbenzene	0.002	0.003	0.003	0.05*	0.06*	0.06*	0.003	0.008	0.006	0.06*	0.15*	0.12*
∑ meta- and para-Xylene	0.007	0.011	0.009	0.02	0.04	0.03	0.009	0.023	0.016	0.03	0.08	0.05
Ortho-Xylene	0.001	0.002	0.002	0.00	0.01	0.01	0.002	0.003	0.002	0.01	0.01	0.01
Isopropylbenzene	0.001	0.002	0.001	0.00	0.00	0.00	0.005	0.007	0.006	0.01	0.01	0.01
Benz(a)pyrene	0.0297	0.0483	0.0416	1.49	2.42	2.08	0.0326	0.0564	0.0478	1.63	2.82	2.39
Total 10 PAHs	1.2895	1.5273	1.4065	1.29*	1.53*	1.41*	1.4289	1.5527	1.5198	1.43*	1.55*	1.52*
Total 7 PCBs	0.095	0.116	0.101	1.58	1.93	1.68	0.114	0.140	0.125	1.89	2.34	2.08
Manganese	83.5	129.0	109.1	0.06	0.09	0.07	86	183.2	131.7	0.06	0.12	0.09
Zinc	36.7	50.2	42.9	0.67	0.91	0.78	13.4	30.2	22.5	0.24	0.55	0.41
Copper	62.8	94.5	74.8	1.90	2.86	2.27	33	56.4	42.5	1.00	1.71	1.29
Nickel	6.4	13.5	9.1	0.32	0.68	0.46	4.6	12.0	8.1	0.23	0.60	0.40
Cobalt	1.2	2.8	1.8	0.06*	0.14*	0.09*	1.5	1.9	1.7	0.08*	0.10*	0.09*
Lead	28.1	42.1	35.7	0.88	1.32	1.11	32.5	75.1	56.3	1.02	2.35	1.76
Cadmium	0.04	0.07	0.05	0.08	0.14	0.10	0.04	0.07	0.06	0.07	0.15	0.12
Chrome	3.3	6.1	4.7	0.55	1.02	0.78	2.5	5.2	4.1	0.42	0.87	0.68
Mercury	<0.003	0.010	0.006	0.00	0.00	0.00	0.007	0.009	0.008	0.00	0.00	0.00

Continuation of Table 5.3-7

Index	Point number											
	S09-087						S09-088					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	7642	15577	11364	152.84*	311.54*	227.28*	11558	21590	16835	231.16*	431.80*	336.70*
Benzene	0.001	0.001	0.001	0.00	0.00	0.00	0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.004	0.010	0.007	0.01	0.03	0.02	0.006	0.010	0.008	0.02	0.03	0.03
Ethylbenzene	0.003	0.007	0.005	0.05*	0.14*	0.10*	0.002	0.003	0.002	0.04*	0.05*	0.05*
∑ meta- and para-Xylene	0.007	0.012	0.009	0.02	0.04	0.03	0.006	0.010	0.009	0.02	0.03	0.03
Ortho-Xylene	0.002	0.004	0.003	0.01	0.01	0.01	0.002	0.003	0.003	0.01	0.01	0.01
Isopropylbenzene	0.003	0.005	0.004	0.01	0.01	0.01	0.005	0.007	0.006	0.01	0.01	0.01
Benz(a)pyrene	0.0416	0.0577	0.0493	2.08	2.89	2.47	0.0268	0.0499	0.0391	1.34	2.50	1.96
Total 10 PAHs	1.3921	1.8673	1.6147	1.39*	1.87*	1.61*	0.9306	1.0591	1.0042	0.93*	1.06*	1.00*
Total 7 PCBs	0.124	0.153	0.140	2.06	2.55	2.34	0.113	0.133	0.122	1.88	2.22	2.03
Manganese	53.0	105.9	83.8	0.04	0.07	0.06	75.1	138.8	111.3	0.05	0.09	0.07
Zinc	12.1	29	21.6	0.06	0.13	0.10	24.0	37.3	32.6	0.44	0.68	0.59
Copper	35.3	76.7	64.7	0.27	0.58	0.49	46.7	78.2	62.3	1.42	2.37	1.89
Nickel	6.2	15.1	10.0	0.08	0.19	0.12	6.3	15.9	10.6	0.32	0.80	0.53
Cobalt	1.3	1.3	1.3	0.07*	0.07*	0.07*	1.2	1.8	1.5	0.06*	0.09	0.08*
Lead	17.9	26.2	23.2	0.56	0.82	0.73	29.7	68.9	55.6	0.93	2.15	1.74
Cadmium	0.03	0.06	0.05	0.01	0.03	0.02	0.07	0.08	0.08	0.15	0.17	0.16
Chrome	3.1	5.4	4.3	0.52	0.90	0.72	1.7	2.0	1.8	0.28	0.33	0.30
Mercury	0.007	0.009	0.008	0.00	0.00	0.00	0.008	0.011	0.010	0.00	0.01	0.00

Index	Point number											
	S09-089						S09-090					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	21595	35563	28678	431.90*	711.26*	573.55*	12450	26388	19410	249.00*	527.76*	388.21*
Benzene	0.001	0.002	0.001	0.00	0.01	0.00	0.001	0.002	0.002	0.00	0.01	0.01
Toluene	0.011	0.025	0.019	0.04	0.08	0.06	0.008	0.016	0.013	0.03	0.05	0.04
Ethylbenzene	0.003	0.008	0.007	0.07*	0.16*	0.13*	0.004	0.007	0.005	0.08*	0.14*	0.11*
∑ meta- and para-Xylene	0.010	0.024	0.018	0.03	0.08	0.06	0.011	0.023	0.017	0.04	0.08	0.06
Ortho-Xylene	0.015	0.018	0.016	0.05	0.06	0.05	0.013	0.018	0.016	0.04	0.06	0.05
Isopropylbenzene	0.003	0.004	0.003	0.01	0.01	0.01	0.002	0.003	0.002	0.00	0.01	0.00
Benz(a)pyrene	0.0487	0.1039	0.0802	2.44	5.20	4.01	0.1263	0.1785	0.1509	6.32	8.93	7.55
Total 10 PAHs	3.9643	6.3869	5.1382	3.96*	6.39*	5.14*	6.5934	8.1066	7.4825	6.59*	8.11*	7.48*
Total 7 PCBs	0.009	0.011	0.010	0.15	0.19	0.17	0.029	0.036	0.032	0.48	0.60	0.53
Manganese	18.4	51.6	36.6	0.01	0.03	0.02	43.3	103.2	75.1	0.03	0.07	0.05
Zinc	34.9	68.9	51.9	0.16	0.31	0.24	40.8	79.5	58.6	0.19	0.36	0.27
Copper	12.9	32.4	25.0	0.10	0.25	0.19	30.0	59.4	48.0	0.23	0.45	0.36
Nickel	2.1	4.7	3.3	0.03	0.06	0.04	4.2	9.7	7.4	0.05	0.12	0.09
Cobalt	5.9	7.9	7.0	0.30*	0.40*	0.35*	5.9	8.2	7.1	0.30*	0.41*	0.36*
Lead	17.9	39.1	30.2	0.56	1.22	0.94	15.7	40.2	30.2	0.49	1.26	0.95
Cadmium	0.10	0.22	0.17	0.05	0.11	0.09	0.14	0.24	0.19	0.07	0.12	0.10
Chrome	3.2	7.3	5.9	0.53	1.22	0.98	3.9	6.2	5.2	0.65	1.03	0.86
Mercury	0.026	0.033	0.029	0.01	0.02	0.01	0.024	0.033	0.028	0.01	0.02	0.01

Continuation of Table 5.3-7

Index	Point number											
	S09-091						S09-092					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	15838	28701	22560	316.76*	574.02*	451.19*	32206	45597	38451	644.12*	911.94*	769.02*
Benzene	0.002	0.002	0.002	0.01	0.01	0.01	0.001	0.002	0.002	0.00	0.01	0.01
Toluene	0.010	0.025	0.019	0.03	0.08	0.06	0.013	0.023	0.020	0.04	0.08	0.07
Ethylbenzene	0.004	0.009	0.007	0.08*	0.18*	0.13*	0.004	0.009	0.007	0.07*	0.17*	0.13*
∑ meta- and para-Xylene	0.008	0.014	0.011	0.03	0.05	0.04	0.013	0.024	0.019	0.04	0.08	0.06
Ortho-Xylene	0.015	0.021	0.018	0.05	0.07	0.06	0.014	0.019	0.016	0.05	0.06	0.05
Isopropylbenzene	0.003	0.004	0.003	0.01	0.01	0.01	0.003	0.004	0.004	0.01	0.01	0.01
Benz(a)pyrene	0.0837	0.1289	0.1129	4.19	6.45	5.65	0.0784	0.1015	0.0932	3.92	5.08	4.66
Total 10 PAHs	5.3412	7.3136	6.5006	5.34*	7.31*	6.50*	5.5863	6.8165	6.2303	5.59*	6.82*	6.23*
Total 7 PCBs	0.011	0.012	0.011	0.18	0.21	0.19	0.009	0.012	0.011	0.16	0.20	0.18
Manganese	30.8	57.9	42.5	0.02	0.04	0.03	46.7	69.6	61.7	0.03	0.05	0.04
Zinc	17.9	30.6	24.1	0.33	0.56	0.44	17.1	26.4	22.4	0.31	0.48	0.41
Copper	32.6	79.2	60.8	0.99	2.40	1.84	28.5	66	46.2	0.86	2.00	1.40
Nickel	4.1	9.8	7.0	0.21	0.49	0.35	2.1	4.4	3.2	0.11	0.22	0.16
Cobalt	6.6	8.8	7.3	0.33*	0.44*	0.37*	6.7	7.9	7.2	0.34*	0.40*	0.36*
Lead	14.8	21.6	17.9	0.46	0.68	0.56	18.2	43.6	36.4	0.57	1.36	1.14
Cadmium	0.06	0.13	0.09	0.11	0.26	0.18	0.09	0.15	0.13	0.19	0.31	0.26
Chrome	7.0	9.8	8.6	1.17	1.63	1.43	5.5	9.8	8.0	0.92	1.63	1.34
Mercury	0.021	0.029	0.023	0.01	0.01	0.01	0.021	0.028	0.024	0.01	0.01	0.01

Index	Point number											
	S09-093						S09-094					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	10640	18070	14040	212.80*	361.40*	280.80*	18505	36750	27765	370.10*	735.00*	555.30*
Benzene	0.001	0.002	0.002	0.00	0.01	0.00	0.002	0.003	0.002	0.01	0.01	0.01
Toluene	0.011	0.016	0.013	0.04	0.05	0.04	0.014	0.024	0.018	0.05	0.08	0.06
Ethylbenzene	0.004	0.007	0.005	0.08*	0.15*	0.11*	0.003	0.006	0.005	0.06*	0.13*	0.09*
∑ meta- and para-Xylene	0.014	0.018	0.016	0.05	0.06	0.05	0.007	0.017	0.012	0.02	0.06	0.04
Ortho-Xylene	0.012	0.015	0.013	0.04	0.05	0.04	0.010	0.020	0.015	0.03	0.07	0.05
Isopropylbenzene	0.002	0.003	0.002	0.00	0.01	0.00	0.001	0.002	0.002	0.00	0.00	0.00
Benz(a)pyrene	0.0031	0.0051	0.0042	0.16	0.26	0.21	0.0434	0.0704	0.0565	2.17	3.52	2.82
Total 10 PAHs	0.4575	0.6478	0.5343	0.46*	0.65*	0.53*	0.9636	1.3204	1.1331	0.96*	1.32*	1.13*
Total 7 PCBs	0.023	0.028	0.026	0.39	0.47	0.43	0.006	0.007	0.006	0.09	0.11	0.10
Manganese	35.5	91.4	63.2	0.02	0.06	0.04	53.1	86.8	70.8	0.04	0.06	0.05
Zinc	21.7	50	36.9	0.39	0.91	0.67	58.3	73.4	65.6	1.06	1.33	1.19
Copper	25.7	53.1	39.4	0.78	1.61	1.19	44.5	57	50.0	1.35	1.73	1.52
Nickel	3.1	7.4	5.1	0.16	0.37	0.26	5.1	7.4	6.2	0.26	0.37	0.31
Cobalt	5.0	6.4	5.7	0.25*	0.32*	0.28*	4.0	5.4	4.8	0.20*	0.27*	0.24*
Lead	12.9	26.1	20.8	0.40	0.82	0.65	8.9	15.4	11.2	0.28	0.48	0.35
Cadmium	0.10	0.15	0.13	0.21	0.29	0.25	0.05	0.16	0.10	0.10	0.32	0.20
Chrome	5.5	8.4	6.9	0.92	1.40	1.15	3.2	5.8	4.5	0.53	0.97	0.76
Mercury	0.020	0.028	0.023	0.01	0.01	0.01	0.005	0.016	0.011	0.00	0.01	0.01

Continuation of Table 5.3-7

Index	Point number											
	S09-095						S09-096					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	13645	30115	22773	272.90*	602.30*	455.46*	12929	26130	19645	258.58*	522.60*	392.91*
Benzene	0.002	0.003	0.003	0.01	0.01	0.01	0.002	0.003	0.002	0.01	0.01	0.01
Toluene	0.009	0.020	0.014	0.03	0.07	0.05	0.013	0.018	0.015	0.04	0.06	0.05
Ethylbenzene	0.003	0.006	0.005	0.06*	0.12*	0.09*	0.002	0.003	0.003	0.05*	0.06*	0.05*
∑ meta- and para-Xylene	0.011	0.019	0.015	0.04	0.06	0.05	0.009	0.019	0.014	0.03	0.06	0.05
Ortho-Xylene	0.015	0.022	0.019	0.05	0.07	0.06	0.014	0.017	0.016	0.05	0.06	0.05
Isopropylbenzene	0.001	0.003	0.002	0.00	0.01	0.00	0.002	0.003	0.003	0.00	0.01	0.01
Benz(a)pyrene	0.0060	0.0078	0.0067	0.30	0.39	0.34	0.0041	0.0083	0.0061	0.21	0.42	0.31
Total 10 PAHs	0.5599	0.6904	0.6192	0.56*	0.69*	0.62*	0.4021	0.6232	0.5573	0.40*	0.62*	0.56*
Total 7 PCBs	0.026	0.034	0.030	0.44	0.56	0.49	0.030	0.037	0.033	0.51	0.62	0.55
Manganese	54.5	111.8	80.9	0.04	0.07	0.05	46.1	90.1	66.0	0.03	0.06	0.04
Zinc	45.7	57.4	53.0	0.21	0.26	0.24	51.2	74.1	58.8	0.23	0.34	0.27
Copper	23.5	45.2	33.7	0.18	0.34	0.26	31.8	75.2	55.1	0.24	0.57	0.42
Nickel	4.2	8.6	6.5	0.05	0.11	0.08	6.3	9.3	7.5	0.08	0.12	0.09
Cobalt	4.5	5.3	4.8	0.23*	0.27*	0.24*	3.9	5	4.5	0.20*	0.25*	0.22*
Lead	6.7	11.2	9.4	0.21	0.35	0.29	6.2	8.2	7.4	0.19	0.26	0.23
Cadmium	0.08	0.12	0.10	0.04	0.06	0.05	0.04	0.10	0.08	0.02	0.05	0.04
Chrome	4.5	7.2	5.9	0.75	1.20	0.98	3.8	5.7	4.7	0.63	0.95	0.78
Mercury	0.009	0.012	0.011	0.00	0.01	0.01	0.010	0.013	0.011	0.00	0.01	0.01

Index	Point number											
	S09-097						S09-098					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	21484	47331	36944	429.68*	946.62*	738.88*	16985	29510	22825	339.70*	590.20*	456.50*
Benzene	0.002	0.003	0.003	0.01	0.01	0.01	0.002	0.003	0.002	0.01	0.01	0.01
Toluene	0.013	0.021	0.017	0.04	0.07	0.06	0.016	0.018	0.017	0.05	0.06	0.06
Ethylbenzene	0.004	0.007	0.005	0.07*	0.14*	0.11*	0.005	0.008	0.007	0.11*	0.16*	0.13*
∑ meta- and para-Xylene	0.013	0.020	0.017	0.04	0.07	0.06	0.020	0.029	0.024	0.07	0.10	0.08
Ortho-Xylene	0.019	0.025	0.021	0.06	0.08	0.07	0.011	0.017	0.014	0.04	0.06	0.05
Isopropylbenzene	0.002	0.003	0.003	0.00	0.01	0.00	0.001	0.004	0.003	0.00	0.01	0.01
Benz(a)pyrene	0.0042	0.0089	0.0071	0.21	0.45	0.35	0.0024	0.0046	0.0034	0.12	0.23	0.17
Total 10 PAHs	0.5403	0.6799	0.6119	0.54*	0.68*	0.61*	0.4963	0.7706	0.6683	0.50*	0.77*	0.67*
Total 7 PCBs	0.024	0.029	0.027	0.40	0.48	0.44	0.007	0.008	0.007	0.11	0.14	0.12
Manganese	36.9	63.2	53.0	0.02	0.04	0.04	55.3	153.7	103.3	0.04	0.10	0.07
Zinc	75.3	116.8	91.5	1.37	2.12	1.66	51.9	100.2	72.9	0.94	1.82	1.33
Copper	18.8	47.9	36.2	0.57	1.45	1.10	52.5	86.8	66.3	1.59	2.63	2.01
Nickel	3.0	6.3	5.1	0.15	0.32	0.25	6.3	13.7	10.4	0.32	0.69	0.52
Cobalt	5.4	6.9	6.1	0.27*	0.35*	0.31*	4.5	5.6	5.3	0.23*	0.28*	0.26*
Lead	6.9	13.4	10.6	0.22	0.42	0.33	5.7	12.1	9.4	0.18	0.38	0.29
Cadmium	0.11	0.16	0.13	0.22	0.32	0.25	0.10	0.18	0.14	0.20	0.36	0.27
Chrome	4.1	6.8	5.6	0.68	1.13	0.93	3.3	4.8	4.1	0.55	0.80	0.69
Mercury	0.013	0.014	0.013	0.01	0.01	0.01	0.009	0.011	0.010	0.00	0.01	0.00

Continuation of Table 5.3-7

Index	Point number											
	S09-099						S09-100					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	14696	22369	19385	293.92*	447.38*	387.71*	17746	32222	27419	354.92*	644.44*	548.38*
Benzene	0.002	0.003	0.002	0.01	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Toluene	0.014	0.021	0.019	0.05	0.07	0.06	0.002	0.021	0.012	0.01	0.07	0.04
Ethylbenzene	0.005	0.007	0.006	0.11*	0.14*	0.13*	0.002	0.006	0.005	0.04*	0.13*	0.09*
∑ meta- and para-Xylene	0.007	0.014	0.011	0.02	0.05	0.04	0.002	0.016	0.009	0.01	0.05	0.03
Ortho-Xylene	0.016	0.022	0.019	0.05	0.07	0.06	0.002	0.016	0.009	0.01	0.05	0.03
Isopropylbenzene	0.003	0.004	0.004	0.01	0.01	0.01	0.002	0.004	0.003	0.00	0.01	0.01
Benz(a)pyrene	0.0593	0.0948	0.0795	2.97	4.74	3.97	0.0519	0.0755	0.0668	2.60	3.78	3.34
Total 10 PAHs	1.0686	1.2343	1.1630	1.07*	1.23*	1.16*	0.7754	1.1092	0.9523	0.78*	1.11*	0.95*
Total 7 PCBs	0.007	0.009	0.008	0.12	0.14	0.13	0.006	0.008	0.007	0.11	0.13	0.12
Manganese	31.6	88.1	61.7	0.02	0.06	0.04	19.3	40.9	29.5	0.01	0.03	0.02
Zinc	20.5	32.1	27.4	0.09	0.15	0.12	32.8	64.2	48.7	0.15	0.29	0.22
Copper	19.7	44.2	30.7	0.15	0.33	0.23	31.4	63.2	49.0	0.24	0.48	0.37
Nickel	4.8	8.4	6.4	0.06	0.11	0.08	6.1	10.1	7.5	0.08	0.13	0.09
Cobalt	4.3	6.1	5.0	0.22*	0.31*	0.25*	5.6	7.7	6.9	0.28*	0.39*	0.34*
Lead	5.0	12.0	9.3	0.16	0.38	0.29	2.9	7.3	5.6	0.09	0.23	0.17
Cadmium	0.15	0.23	0.18	0.07	0.12	0.09	0.07	0.18	0.14	0.03	0.09	0.07
Chrome	4.1	9.5	7.0	0.68	1.58	1.17	5.3	6.8	6.0	0.88	1.13	1.00
Mercury	0.007	0.008	0.007	0.00	0.00	0.00	0.005	0.007	0.006	0.00	0.00	0.00

Index	Point number											
	S09-101						S09-102					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	13709	33646	25503	274.18*	672.92*	510.05*	10290	16162	13951	205.80*	323.24*	279.02*
Benzene	0.002	0.003	0.002	0.01	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Toluene	0.012	0.023	0.017	0.04	0.08	0.06	0.005	0.008	0.007	0.02	0.03	0.02
Ethylbenzene	0.004	0.010	0.007	0.08*	0.19*	0.14*	0.003	0.005	0.004	0.06*	0.11*	0.08*
∑ meta- and para-Xylene	0.015	0.023	0.020	0.05	0.08	0.07	0.009	0.015	0.012	0.03	0.05	0.04
Ortho-Xylene	0.012	0.019	0.016	0.04	0.06	0.05	0.006	0.014	0.011	0.02	0.05	0.04
Isopropylbenzene	0.003	0.004	0.003	0.01	0.01	0.01	0.001	0.002	0.002	0.00	0.00	0.00
Benz(a)pyrene	0.0373	0.0641	0.0510	1.87	3.21	2.55	0.0287	0.0431	0.0361	1.44	2.16	1.81
Total 10 PAHs	0.7825	1.0741	0.9609	0.78*	1.07*	0.96*	0.8781	1.0481	0.9616	0.88*	1.05*	0.96*
Total 7 PCBs	0.007	0.008	0.008	0.12	0.14	0.13	0.007	0.008	0.008	0.12	0.14	0.13
Manganese	17.4	48.1	31.0	0.01	0.03	0.02	40.7	109.2	77.1	0.03	0.07	0.05
Zinc	36.7	62.8	52.0	0.17	0.29	0.24	37.8	97.6	72.4	0.17	0.44	0.33
Copper	15.9	35.9	25.8	0.12	0.27	0.20	32.6	87.3	61.7	0.25	0.66	0.47
Nickel	2.5	5.8	4.4	0.03	0.07	0.06	4.6	8.9	7.4	0.06	0.11	0.09
Cobalt	4.5	6.2	5.2	0.23*	0.31*	0.26*	4.3	5.4	4.8	0.22*	0.27*	0.24*
Lead	7.7	16.1	12.0	0.24	0.50	0.37	7.1	14.5	11.9	0.22	0.45	0.37
Cadmium	0.12	0.25	0.21	0.06	0.13	0.10	0.14	0.22	0.19	0.07	0.11	0.09
Chrome	6.5	9.9	8.4	1.08	1.65	1.40	2.3	3.9	3.2	0.38	0.65	0.53
Mercury	0.007	0.009	0.008	0.00	0.00	0.00	0.005	0.006	0.005	0.00	0.00	0.00

Continuation of Table 5.3-7

Index	Point number					
	S10-103					
	Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.
Oil products	953	1880	1231	19.06*	37.60*	24.62*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	0.001	0.002	0.002	0.00	0.01	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.002	0.003	0.002	0.01	0.01	0.01
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0018	0.0033	0.0025	0.09	0.17	0.13
Total 10 PAHs	0.4718	0.6604	0.5632	0.47*	0.66*	0.56*
Total 7 PCBs	0.004	0.004	0.004	0.06	0.07	0.07
Manganese	26.2	58.8	44.7	0.02	0.04	0.03
Zinc	12.9	26	21.2	0.23	0.47	0.38
Copper	20.7	57.9	43.2	0.63	1.75	1.31
Nickel	3.3	7.2	5.8	0.17	0.36	0.29
Cobalt	4.0	5.5	4.5	0.20*	0.28*	0.23*
Lead	18.3	34.7	27.9	0.57	1.08	0.87
Cadmium	0.61	0.75	0.69	1.22	1.50	1.38
Chrome	4.8	7.5	6.0	0.80	1.25	1.00
Mercury	0.528	0.728	0.662	0.25	0.35	0.32

The values of measured concentrations of soil indices to be monitored are given in summary tables in Appendix 3.

40 soil samples at 8 points of geocological testing were collected **at site 10 on Alexandra Island (fuel and lubricant storage facility near the settlement of Nagurskoe)**

Assessment according to Russian standards

The content of VAH compounds in soils at the site amounted to:

- benzene - 0.011 mg/kg (up to 0.04 MPC units),
- toluene - 0.061 mg/kg (up to 0.20 MPC units)
- ∑ meta- and para-xylene - 0.012 mg/kg (up to 0.04 MPC units),
- ortho-xylene - 0.013 mg/kg (up to 0.04 MPC units),
- isopropylbenzene - 0.004 mg/kg (up to 0.01 MPC units).

The content of benz(a)pyrene amounted to 0.0328 mg/kg (up to 1.64 MPC units, point S10-109). The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents.

The content of heavy metals reached:

- manganese - 124 mg/kg (up to 0.08 MPC units, point S10-109);
- zinc - 54.3 mg/kg (up to 1.06 APC units, point S10-108);
- copper - 143 mg/kg (up to 3.82 APC units, point S10-109);
- nickel - 26.2 mg/kg (up to 0.84 APC units, point S10-109);
- lead - 295 mg/kg (up to 9.22 MPC units, point S10-109);
- chrome (mobile form) - 6.8 mg/kg (up to 1.13 MPC units, point S10-108);
- cadmium - 0.99 mg/kg (up to 1.98 APC units, point S10-106);
- mercury - 0.654 mg/kg (up to 0.31 MPC units, point S10-106).

The total PCB content reached up to 0.076 mg/kg (up to 1.2 APC units, point S10-109).

Intervals of pollutant content in soils at site's 10 points of geocological testing in mass concentration values and MPC, APC and PC units are given in Table 5.3-9 at the end of the Section

Table 5.3-8 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards

Table 5.3-8 Assessment of the levels of soil contamination at the fuel and lubricant storage facility area near the settlement of Nagurskoe (site 10) according to SanPiN 2.1.7.1287-03 and international standards

Index	Site 10									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	9105							4.86	**863.20***	**204.59***
Benzene	0.002	0.00	0.04	0.01	permissible	permissible	permissible	0.00	0.22	0.04
Toluene	0.012	0.00	0.20	0.04	permissible	permissible	permissible	0.00	0.12	0.03
Ethylbenzene	0.002					permissible	permissible	0.00	0.19	0.05
∑ meta- and para-Xylene	0.006	0.01	0.04	0.02	permissible	permissible	permissible	0.00	0.02	0.01
Ortho-Xylene	0.003	0.00	0.04	0.01	permissible	permissible	permissible	0.00	0.03	0.01
Isopropylbenzene	0.001	0.00	0.01	0.00	permissible	permissible	permissible			
Benz(a)pyrene	0.0120	0.04	1.64	0.60	permissible	hazardous	permissible			
Total 10 PAHs	0.5622							0.25	1.10	0.56
Total 7 PCBs	0.021	0.02	1.27	0.38	permissible	permissible	permissible	0.05	3.82	1.15
Manganese	75.1	0.02	0.08	0.05	permissible	permissible	permissible			
Zinc	26.1	0.06	1.06	0.38	permissible	extra-hazardous	permissible	0.06	0.39	0.19
Copper	78.4	0.31	3.82	1.71	permissible	extra-hazardous	extra-hazardous	0.67	3.97	2.32
Nickel	10.9	0.06	0.84	0.38	permissible	permissible	permissible	0.12	0.75	0.33
Cobalt	4.0							0.10	0.29	0.20
Lead	86.3	0.07	9.22	2.70	permissible	extra-hazardous	extra-hazardous	0.03	3.47	1.11
Cadmium	0.47	0.10	1.98	0.62	permissible	extra-hazardous	permissible	0.13	1.24	0.54
Chrome	3.8	0.28	1.13	0.59	permissible	extra-hazardous	permissible	0.02	0.07	0.04
Mercury	0.279	0.01	0.35	0.13	permissible	permissible	permissible	0.07	2.18	0.75
Zc	22.62						moderately hazardous			

Note: * - values exceed the intervention level (IL)

In terms of the average content of volatile aromatic hydrocarbons, benz(a)pyrene, the total PCB, manganese, zinc, nickel, cadmium, chrome and mercury, site's 10 soil belong to the **permissible** contamination class; in terms of the average content of **copper** and **lead** – to the **extra-hazardous** contamination class.

The values of the total soil pollution index Zc calculated for a series of metals varied from 11.05 (**permissible** contamination class) to 47.13 (**hazardous** contamination class), while the average value for the site was 22.6 (**moderately hazardous** contamination class).

At the same time, at all testing points (except for S09-101), in part of samples, the MPC or APC for zinc, copper, lead, cadmium and chrome and Kmax values (according to Methodological Guidelines 2.1.7.730-99) were exceeded to correspond toto the **extra-hazardous** soil contamination class.

In general, the level of soil contamination at the surveyed area of the fuel and lubricant storage facility near the settlement of Nagurskoe can be assessed as **extra-hazardous**.

Assessment according to international standards

Permissible concentrations (PC) of oil products, total PAHs, total PCBs, copper, lead, cadmium and mercury were exceeded in the site's soils at separate points, including:

- oil products – up to 863 PC units;
- total PAHs – up to 1.10 PC units;
- total PCBs – up to 3.82 PC units;
- copper – up to 3.97 PC units;
- lead – up to 3.47PC units;
- cadmium – up to 1.24 PC units;
- mercury – up to 2.18 PC units.

In general, the average content of pollutants for the site exceeds the PC values as follows: oil products – 205 times; total PCBs – 1.2 times; copper – 1.3 times and lead – 1.1 times.

It is necessary to pay special attention to the fact that the level of soil contamination with oil products at the site **exceeds the intervention level** both in the average value (2 times) and in the values at separate points of geocological testing (up to 8.6 IL).

Figures 5.3-5 – 5.3-8 show spatial characteristics of the level of site's 10 soil contamination with oil products, total PAHs, total PCBs in PC units and integrated pollution with heavy metals in Zc units.

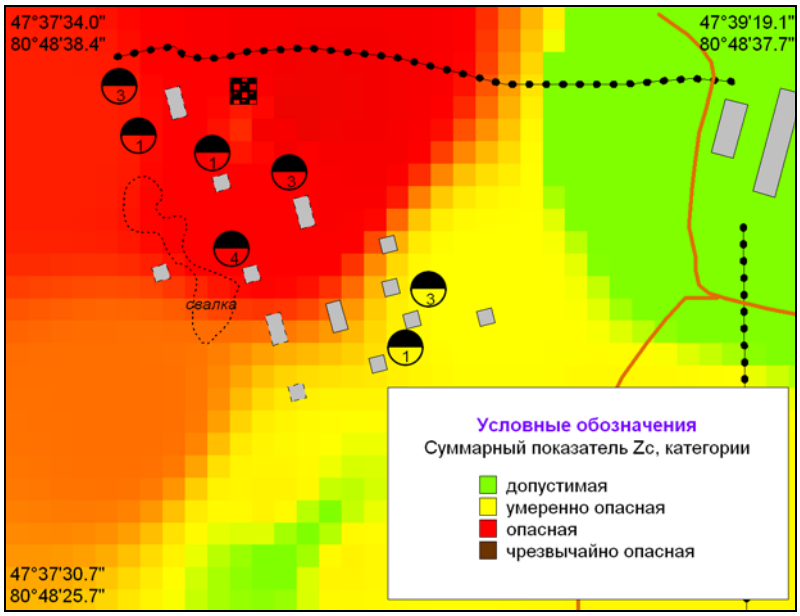


Figure 5.3-5 Spatial characteristics of the level of soil contamination of the fuel and lubricant storage facility near the settlement of Nagurskoe (site 10) with a series of heavy metals (Zc)

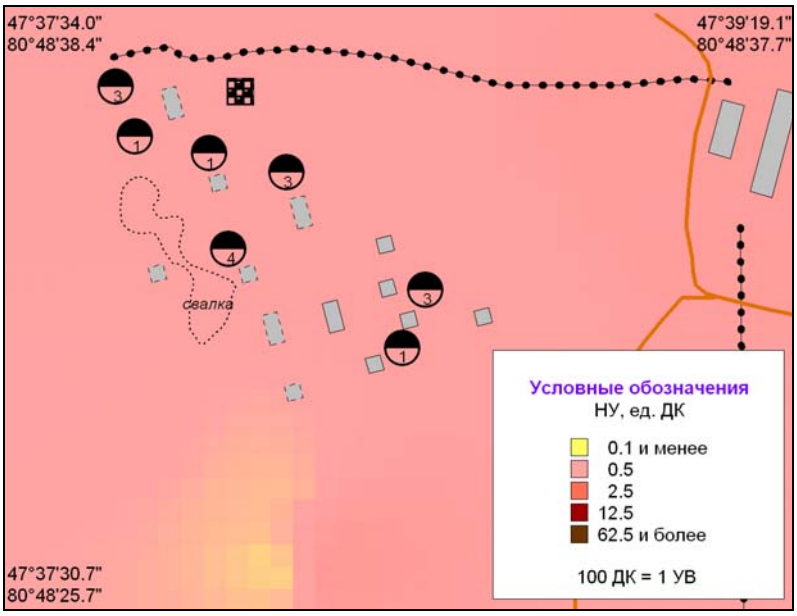
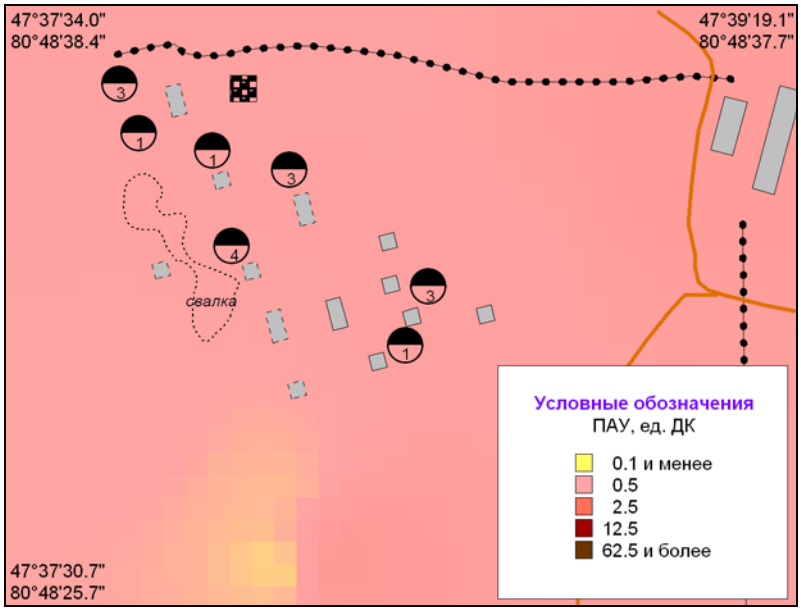
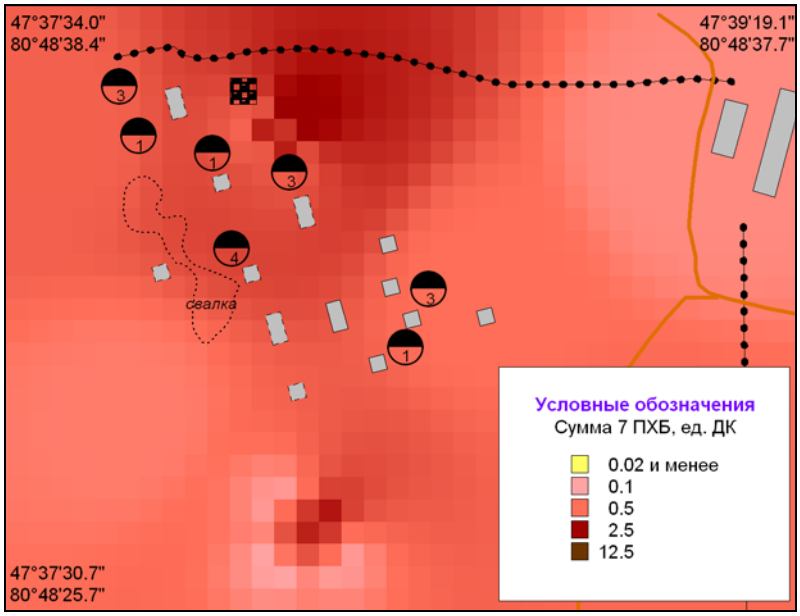


Figure 5.3-6 Spatial characteristics of the level of soil contamination of the fuel and lubricant storage facility near the settlement of Nagurskoe (site 10) with petroleum hydrocarbons (oil products)



Note: Total 10 PAHs - anthracene, benz(a)anthracene, benz(k)fluoranthene, benz(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(123cd)pyrene, naphthalene, benz(ghi)perylene)

Figure 5.3-7 Spatial characteristics of the level of soil contamination of the fuel and lubricant storage facility near the settlement of Nagurskoe (site 10) with polycyclic aromatic hydrocarbons



Note: Total 7 PCBs - #28, #52, #101, #118, #138, #153, #180

Figure 5.3-8 Spatial characteristics of the level of soil contamination of the fuel and lubricant storage facility near the settlement of Nagurskoe (site 10) with polychlorinated biphenyls

Table 5.3-9 Content of pollutants in the intervals of mass concentration and MPC, APC and PC units in soils at site's 10 points

Index	Point number											
	S01-014						S10-104					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	3124	5250	4025	62.48*	105*	80.49*	8240	15240	12339	164.80*	304.80*	246.78*
Benzene	<0.001	0.001	0.001	0.00	0.00	0.00	0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.001	0.002	0.001	0.00	0.01	0.00	0.006	0.009	0.008	0.02	0.03	0.03
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	0.005	0.008	0.007	0.11*	0.16*	0.13*
∑ meta- and para-Xylene	0.001	0.002	0.002	0.00	0.01	0.01	0.006	0.008	0.007	0.02	0.03	0.02
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.002	0.003	0.002	0.01	0.01	0.01
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.003	0.004	0.003	0.01	0.01	0.01
Benz(a)pyrene	0.0092	0.0157	0.0117	0.46	0.79	0.59	0.0038	0.0057	0.0047	0.19	0.29	0.23
Total 10 PAHs	0.5709	0.8800	0.7336	0.57*	0.88*	0.73*	0.3313	0.4580	0.3952	0.33*	0.46*	0.40*
Total 7 PCBs	0.006	0.006	0.006	0.09	0.11	0.10	0.003	0.003	0.003	0.05	0.05	0.05
Manganese	71.5	137.0	111.1	0.05	0.09	0.07	79.4	93.0	85.2	0.05	0.06	0.06
Zinc	53.1	58.3	55.7	0.97	1.06	1.01	25.3	34.2	29.5	0.46	0.62	0.54
Copper	53.2	68.1	62.6	1.61	2.06	1.90	81.5	94.6	86.8	2.47	2.87	2.63
Nickel	10.9	16.8	13.4	0.55	0.84	0.67	7.5	11.2	9.4	0.38	0.56	0.47
Cobalt	3.1	6.2	4.7	0.16*	0.31*	0.23*	3.7	5.2	4.3	0.19*	0.26*	0.21*
Lead	11.1	18.3	14.6	0.35	0.57	0.46	18.4	26.4	22.6	0.58	0.83	0.71
Cadmium	0.07	0.30	0.18	0.14	0.60	0.37	0.10	0.60	0.34	0.20	1.20	0.68
Chrome	3.4	5.3	4.4	0.57	0.88	0.73	3.1	4.3	3.7	0.52	0.72	0.62
Mercury	0.050	0.200	0.116	0.02	0.10	0.06	0.200	0.600	0.360	0.10	0.29	0.17

Index	Point number											
	S10-105						S10-106					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	746	1378	1009	14.92*	27.56*	20.18*	243	416	314	4.86*	8.32*	6.28*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00	0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.005	0.004	0.01	0.02	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.004	0.003	0.01	0.01	0.01
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.010	0.013	0.011	0.03	0.04	0.04
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0198	0.0318	0.0259	0.99	1.59	1.30	0.0062	0.0113	0.0096	0.31	0.57	0.48
Total 10 PAHs	0.6818	1.0996	0.9124	0.68*	1.10*	0.91*	0.6048	0.6596	0.6272	0.60*	0.66*	0.63*
Total 7 PCBs	0.002	0.003	0.003	0.04	0.05	0.05	0.052	0.063	0.057	0.87	1.05	0.95
Manganese	76.4	83.1	79.6	0.05	0.06	0.05	50	108.8	80.8	0.03	0.07	0.05
Zinc	17.2	26.7	22.7	0.31	0.49	0.41	8.2	15.9	11.1	0.15	0.29	0.20
Copper	87.2	113	101.7	2.64	3.42	3.08	24.2	53.6	39.6	0.73	1.62	1.20
Nickel	10.2	15.1	12.4	0.51	0.76	0.62	4.2	8.2	5.7	0.21	0.41	0.29
Cobalt	3.3	4.5	4.0	0.17*	0.23*	0.20*	4.3	5.7	4.9	0.22*	0.29*	0.25*
Lead	6.5	10.2	8.2	0.20	0.32	0.26	8.8	15.9	12.1	0.28	0.50	0.38
Cadmium	0.30	0.70	0.46	0.60	1.40	0.92	0.44	0.99	0.72	0.89	1.98	1.43
Chrome	2.4	3.9	3.0	0.40	0.65	0.51	2.1	3.0	2.6	0.35	0.50	0.43
Mercury	0.1	0.3	0.220	0.05	0.14	0.10	0.428	0.654	0.534	0.20	0.31	0.25

Continuation of Table 5.3-9

Index	Point number											
	S10-107						S10-108					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	261	673	488	5.22*	13.46*	9.76*	8461	16385	11992	169.22*	327.70*	239.84*
Benzene	0.001	0.002	0.001	0.00	0.01	0.00	0.009	0.011	0.010	0.03	0.04	0.03
Toluene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.054	0.061	0.058	0.18	0.20	0.19
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.004	0.006	0.005	0.01	0.02	0.02	0.008	0.012	0.011	0.03	0.04	0.03
Ortho-Xylene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.004	0.003	0.01	0.01	0.01
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0007	0.0010	0.0009	0.04	0.05	0.04	0.0159	0.0195	0.0179	0.80	0.98	0.90
Total 10 PAHs	0.2469	0.3301	0.2964	0.25*	0.33*	0.30*	0.4642	0.6964	0.5904	0.46*	0.70*	0.59*
Total 7 PCBs	0.001	0.001	0.001	0.02	0.02	0.02	0.014	0.017	0.016	0.24	0.29	0.26
Manganese	41.3	64.2	54.7	0.03	0.04	0.04	62.3	92.1	76.7	0.04	0.06	0.05
Zinc	13.2	26.7	20.4	0.24	0.49	0.37	37.5	54.3	46.3	0.17	0.25	0.21
Copper	73.4	126	97.1	2.22	3.82	2.94	68.1	113	90.1	0.52	0.86	0.68
Nickel	5.6	14.7	9.1	0.28	0.74	0.46	12.1	18.4	15.1	0.15	0.23	0.19
Cobalt	1.9	3.5	2.6	0.10*	0.18*	0.13*	3.3	4.6	4.0	0.17*	0.23*	0.20*
Lead	2.2	5.1	3.3	0.07	0.16	0.10	108	210.0	158.0	3.38	6.56	4.94
Cadmium	0.40	0.70	0.52	0.80	1.40	1.04	0.20	0.40	0.26	0.10	0.20	0.13
Chrome	1.8	4.7	3.3	0.30	0.78	0.56	3.2	6.8	4.4	0.53	1.13	0.73
Mercury	0.1	0.5	0.200	0.05	0.24	0.10	0.1	0.3	0.180	0.05	0.14	0.09

Index	Point number											
	S10-109						S10-110					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	13280	43160	31124	265.60*	863.20*	622.48*	6431	21060	14342	128.62*	421.20*	286.84*
Benzene	0.001	0.002	0.001	0.00	0.01	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	0.011	0.014	0.012	0.04	0.05	0.04	0.006	0.008	0.007	0.02	0.03	0.02
Ethylbenzene	0.006	0.010	0.008	0.13*	0.19*	0.15*	0.003	0.003	0.003	0.05*	0.07*	0.06*
∑ meta- and para-Xylene	0.009	0.012	0.011	0.03	0.04	0.04	0.004	0.006	0.005	0.01	0.02	0.02
Ortho-Xylene	0.004	0.007	0.005	0.01	0.02	0.02	0.002	0.002	0.002	0.01	0.01	0.01
Isopropylbenzene	0.002	0.004	0.003	0.00	0.01	0.01	0.002	0.002	0.002	0.00	0.00	0.00
Benz(a)pyrene	0.0174	0.0328	0.0268	0.87	1.64	1.34	0.0054	0.0100	0.0076	0.27	0.50	0.38
Total 10 PAHs	0.4842	0.6132	0.5645	0.48*	0.61*	0.56*	0.4994	0.5839	0.5484	0.50*	0.58*	0.55*
Total 7 PCBs	0.062	0.076	0.068	1.04	1.27	1.14	0.012	0.014	0.013	0.20	0.23	0.21
Manganese	74.5	124.0	90.7	0.05	0.08	0.06	61.8	107.0	88.6	0.04	0.07	0.06
Zinc	24.6	52.1	40.8	0.11	0.24	0.19	12.3	22.8	16.9	0.06	0.10	0.08
Copper	92.8	143	112.5	0.70	1.08	0.85	41	68.2	55.9	0.31	0.52	0.42
Nickel	17.1	26.2	22.1	0.21	0.33	0.28	4.4	10.5	7.7	0.06	0.13	0.10
Cobalt	3.2	5.4	4.4	0.16*	0.27*	0.22*	2.9	4	3.6	0.15	0.20*	0.18*
Lead	214	295.0	255.6	6.69	9.22	7.99	131	258.0	202.2	4.09	8.06	6.32
Cadmium	0.30	0.60	0.46	0.15	0.30	0.23	0.25	0.33	0.29	0.13	0.17	0.15
Chrome	4.3	5.7	5.0	0.72	0.95	0.83	1.7	3.2	2.7	0.01	0.01	0.01
Mercury	0.02	0.07	0.050	0.01	0.03	0.02	0.02	0.027	0.023	0.01	0.01	0.01

5.3.1.2 Fuel and lubricant storage facility in Severnaya Bay (site 1)

65 soil samples at 13 points of geocological testing were collected **at site 1 on Alexandra Island (fuel and lubricant storage facility in Severnaya Bay)**

Assessment according to Russian standards

The content of VAH compounds in soils at the site did not exceed tenths of MPC and amounted to:

- benzene - 0.002 mg/kg (up to 0.01 MPC units);
- toluene - 0.003 mg/kg (up to 0.01 MPC units);
- ∑ meta- and para-xylene - 0.004 mg/kg (up to 0.01 MPC units);
- ortho-xylene – all values were below the lowest detection limit of the analysis technique;
- isopropylbenzene – all values were below the lowest detection limit of the analysis technique.

The content of benz(a)pyrene amounted to 0.2374 mg/kg (up to 11.87 MPC units, point S01-003). The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents.

The content of heavy metals reached:

- manganese - 245.8 mg/kg (up to 0.16 MPC units, point S01-002);
- zinc - 174.4 mg/kg (up to 2.74 APC units, point S01-010);
- copper - 160.9 mg/kg (up to 4.52 APC units, point S01-008);
- nickel - 51.4 mg/kg (up to 1.49 APC units, point S01-010);
- lead - 108.7 mg/kg (up to 3.40 MPC units, point S01-006);
- chrome (mobile form) – 11.2 mg/kg (up to 1.87 MPC units, point S01-004);
- cadmium - 0.13 mg/kg (up to 0.22 APC units, point S01-001);
- mercury - 0.060 mg/kg (up to 0.03 MPC units, point S01-011).

The total PCB content reached up to 0.005 mg/kg (up to 0.5 APC units, point S01-013)

Intervals of pollutant content in soils at site's 1 points of geocological testing in mass concentration values and MPC, APC and PC units are given in Table 5.3-11 at the end of the Section.

Table 5.3-10 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards

Table 5.3-10 Assessment of the levels of soil contamination at the fuel and lubricant storage facility area in Severnaya Bay (site 1) according to SanPiN 2.1.7.1287-03 and international standards

Index	site 1									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	33344							46.72	**2627.6***	**666.88***
Benzene	0.001	0.00	0.01	0.00	permissible	permissible	permissible	0.00	0.04	0.02
Toluene	0.001	0.00	0.01	0.00	permissible	permissible	permissible	0.00	0.01	0.00
Ethylbenzene	<0.001					permissible	permissible	0.00	0.00	0.00
∑ meta- and para-Xylene	0.002	0.00	0.01	0.01	permissible	permissible	permissible	0.00	0.01	0.00
Ortho-Xylene	<0.001	0.00	0.00	0.00	permissible	permissible	permissible	0.00	0.00	0.00
Isopropylbenzene	<0.001	0.00	0.00	0.00	permissible	permissible	permissible			
Benz(a)pyrene	0.0827	0.23	11.87	4.14	permissible	extra-hazardous	hazardous			
Total 10 PAHs	8.7778							0.16	25.03	8.78
Total 7 PCBs	0.019	0.10	0.52	0.32	permissible	permissible	permissible	0.31	1.57	0.97
Manganese	107.1	0.02	0.16	0.07	permissible	permissible	permissible			
Zinc	89.1	0.12	2.74	0.68	permissible	extra-hazardous	extra-hazardous	0.19	1.25	0.64
Copper	85.5	0.26	4.52	1.10	permissible	extra-hazardous	extra-hazardous	0.95	4.47	2.38
Nickel	22.6	0.10	1.49	0.44	permissible	extra-hazardous	permissible	0.22	1.47	0.65
Cobalt	5.7							0.16	0.46	0.28
Lead	57.7	0.55	3.40	1.80	permissible	extra-hazardous	extra-hazardous	0.21	1.28	0.68
Cadmium	0.07	0.01	0.22	0.06	permissible	permissible	permissible	0.03	0.16	0.08
Chrome	6.6	0.53	1.87	1.10	permissible	extra-hazardous	extra-hazardous	0.03	0.11	0.07
Mercury	0.033	0.00	0.03	0.02	permissible	permissible	permissible	0.03	0.20	0.11
Zc metals	19.94						moderately hazardous			

Note: * - values exceed the intervention level (IL)

In terms of the average content of volatile aromatic hydrocarbons, the total PCB, manganese, lead, nickel, cadmium and mercury, site's 1 soil belong to the **permissible** contamination class; in terms of the average content of **benz(a)pyrene** – to the **hazardous** contamination class; in terms of the content of **zinc, copper** and **lead –** to the **extra-hazardous** contamination class.

The values of the total soil pollution index Zc calculated for a series of metals varied from 8.93 (**permissible** contamination class) to 38.2 (**hazardous** contamination class), while the average value for the site was 19.9 (**moderately hazardous** contamination class).

At the same time, at all testing points, in part of samples, the MPC or APC for zinc, copper, nickel, lead and chrome and Kmax values (according to Methodological Guidelines 2.1.7.730-99) were exceeded to correspond to the **extra-hazardous** soil contamination class.

In general, the level of soil contamination at the surveyed area of the fuel and lubricant storage facility in Severnaya Bay can be assessed as **extra-hazardous.**

Assessment according to international standards

Permissible concentrations (PC) of oil products, total PAHs, total PCBs, zinc, copper, nickel and lead were exceeded in the site's soils at separate points, including:

- oil products - up to 2628 PC units;

- total PAHs - up to 25 PC units;
- total PCBs – up to 1.6 PC units;
- zinc - up to 1.3 PC units;
- copper - up to 4.5 PC units;
- nickel – up to 1.5 PC units;
- lead - up to 1.3 PC units.

In general, the average content of pollutants for the site exceeds the PC values as follows: oil products – 667 times; total PAHs – 8.8 times and copper – 2.4 times.

It is necessary to pay special attention to the fact that the level of soil contamination with oil products at the site **exceeds the intervention level** both in the average value (6.7 times) and in the values at separate points of geocological testing (up to 26.3 IL).

Figures 5.3-1 - 5.3-4 show spatial characteristics of the level of site's 1 soil contamination with oil products, total PAHs, total PCBs in PC units and integrated pollution with heavy metals in Zc units.

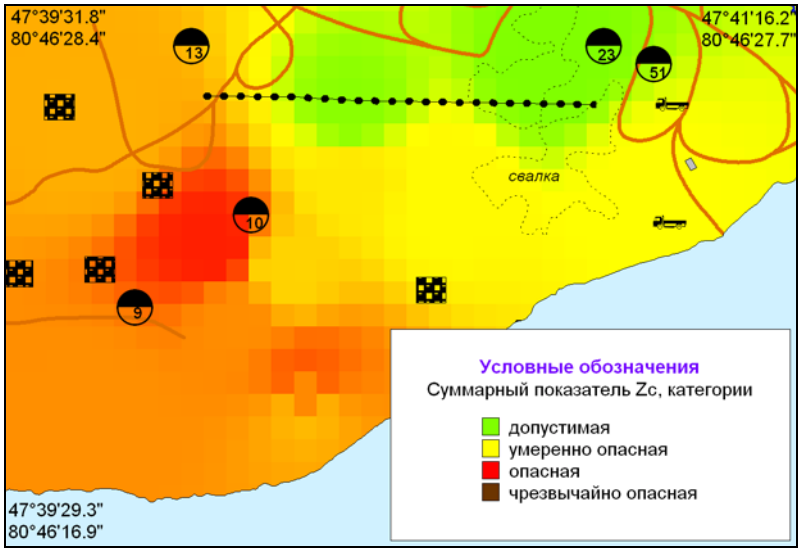


Figure 5.3-9 Spatial characteristics of the level of soil contamination of the fuel and lubricant storage facility in Severnaya Bay (site 1) with a series of heavy metals (Zc)

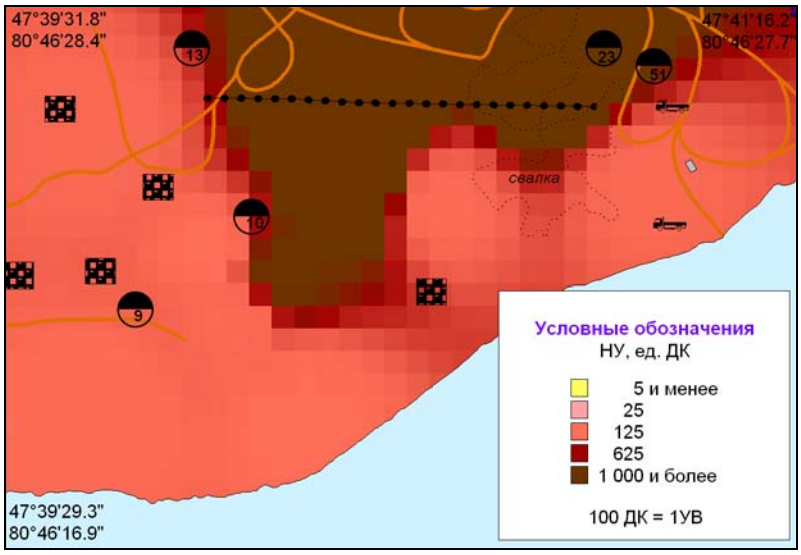
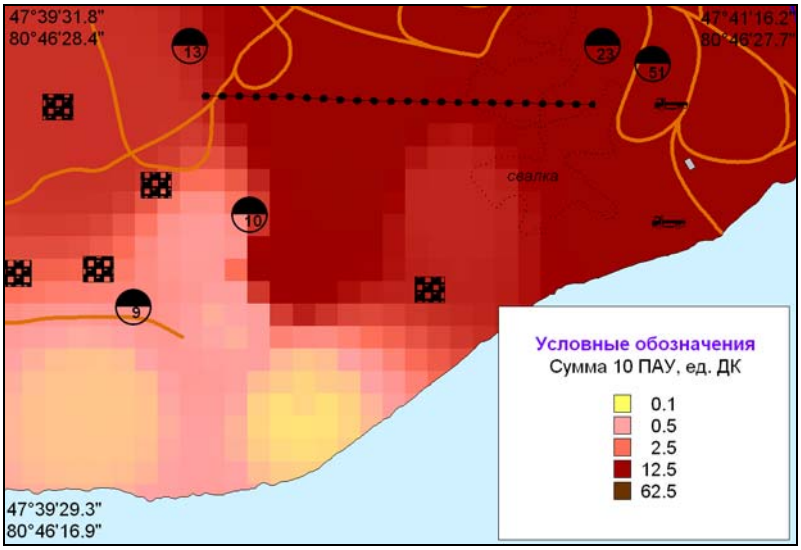
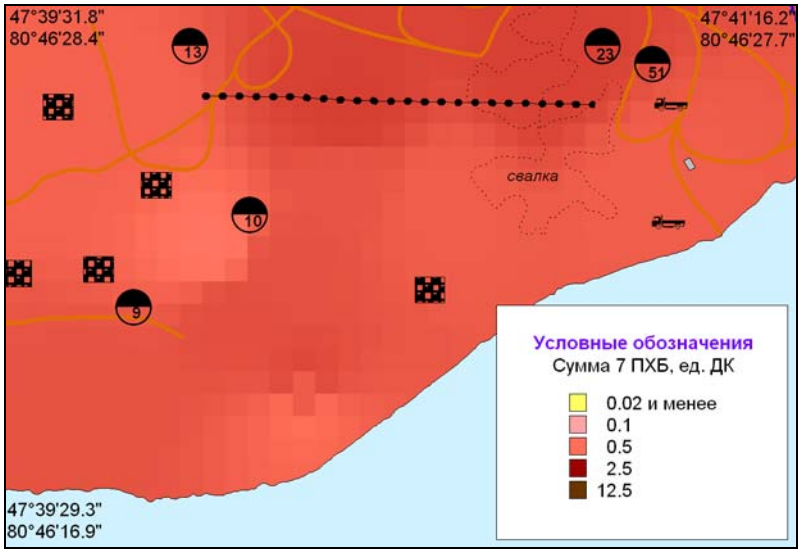


Figure 5.3-10 Spatial characteristics of the level of soil contamination of the fuel and lubricant storage facility in Severnaya Bay (site 1) with petroleum hydrocarbons (oil products)



Note: Total 10 PAHs - anthracene, benz(a)anthracene, benz(k)fluoranthene, benz(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(123cd)pyrene, naphthalene, benz(ghi)perylene)

Figure 5.3-11 Spatial characteristics of the level of soil contamination of the fuel and lubricant storage facility in Severnaya Bay (site 1) with polycyclic aromatic hydrocarbons



Note: Total 7 PCBs - #28, #52, #101, #118, #138, #153, #180

Figure 5.3-12 Spatial characteristics of the level of soil contamination of the fuel and lubricant storage facility in Severnaya Bay (site 1) with polychlorinated biphenyls

Table 5.3-11 Content of pollutants in the intervals of mass concentration and MPC, APC and PC units in soils at site's 1 points

Index	Point number											
	S01-001						S01-002					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	4341	10881	7984	86.82*	217.62*	159.68*	3603	7393	6104	72.06*	147.86*	122.08*
Benzene	<0.001	0.002	0.002	0.00	0.01	0.00	<0.001	0.002	<0.001	0.00	0.01	0.00
Toluene	<0.001	0.002	0.001	0.00	0.01	0.00	<0.001	0.002	<0.001	0.00	0.01	0.00
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	<0.001	0.002	0.001	0.00	0.01	0.00	0.001	0.002	0.002	0.00	0.01	0.00
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0917	0.1448	0.1227	4.59	7.24	6.13	0.0092	0.0202	0.0147	0.46	1.01	0.74
Total 10 PAHs	14.8782	20.2057	17.6604	14.88*	20.21*	17.66*	0.2010	0.3002	0.2540	0.20*	0.30*	0.25*
Total 7 PCBs	0.021	0.025	0.024	0.35	0.42	0.39	0.008	0.009	0.009	0.13	0.15	0.14
Manganese	37.4	86.0	62.8	0.02	0.06	0.04	104.3	245.8	161.8	0.07	0.16	0.11
Zinc	26.0	66.8	50.4	0.12	0.30	0.23	46.5	92.7	71.5	0.21	0.42	0.33
Copper	45.9	79.9	58.2	0.35	0.61	0.44	50.6	133	92.6	0.38	1.01	0.70
Nickel	8.7	18.2	14.2	0.11	0.23	0.18	8.1	18.4	13.6	0.10	0.23	0.17
Cobalt	5.9	7.3	6.5	0.30*	0.37*	0.32*	4.7	6.2	5.4	0.24*	0.31*	0.27*
Lead	23.6	46.0	38.1	0.74	1.44	1.19	47	91.4	74.6	1.47	2.86	2.33
Cadmium	0.07	0.13	0.10	0.04	0.06	0.05	0.03	0.07	0.06	0.02	0.04	0.03
Chrome	3.8	8.3	6.8	0.63	1.38	1.13	5.1	8.7	7.4	0.85	1.45	1.23
Mercury	0.021	0.024	0.022	0.01	0.01	0.01	0.031	0.041	0.036	0.01	0.02	0.02

Index	Point number											
	S01-003						S01-004					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	24801	51359	38351	496.02*	1027.18*	767.03*	80038	131380	105179	1600.76*	2627.6*	2103.58*
Benzene	<0.001	0.002	0.001	0.00	0.01	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	<0.001	0.002	0.001	0.00	0.01	0.00	<0.001	0.002	0.001	0.00	0.01	0.00
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	<0.001	0.001	0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.1187	0.2374	0.1885	5.94	11.87	9.42	0.1424	0.2303	0.1883	7.12	11.52	9.42
Total 10 PAHs	20.5043	25.0338	23.3354	20.50*	25.03*	23.34*	17.7242	21.5322	20.0771	17.72*	21.53*	20.08*
Total 7 PCBs	0.023	0.029	0.026	0.39	0.48	0.44	0.025	0.030	0.028	0.42	0.50	0.46
Manganese	69.5	124.9	95.0	0.05	0.08	0.06	54.9	108.9	81.8	0.04	0.07	0.05
Zinc	74.7	161.5	122.8	0.34	0.73	0.56	50.1	89.9	74.3	0.23	0.41	0.34
Copper	52.5	78.1	62.9	0.40	0.59	0.48	34.3	61.5	46.4	0.26	0.47	0.35
Nickel	22.8	39	30.5	0.29	0.49	0.38	14	22.4	17.9	0.18	0.28	0.22
Cobalt	5.7	8.4	7.0	0.29*	0.42*	0.35*	6.2	8.6	7.6	0.31*	0.43*	0.38*
Lead	37.2	57.3	47.3	1.16	1.79	1.48	38.5	61.8	51.1	1.20	1.93	1.60
Cadmium	0.06	0.09	0.08	0.03	0.05	0.04	0.08	0.13	0.10	0.04	0.06	0.05
Chrome	3.8	5.8	5.1	0.63	0.97	0.85	7.4	11.2	9.3	1.23	1.87	1.56
Mercury	0.020	0.027	0.022	0.01	0.01	0.01	0.025	0.032	0.028	0.01	0.02	0.01

Continuation of Table 5.3-11

Index	Point number											
	S01-005						S01-006					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	2336	7134	5201	46.72*	142.68*	104.02*	5141	11417	7130	102.82*	228.34*	142.60*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	<0.001	0.002	0.001	0.00	0.01	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.001	0.002	0.001	0.00	0.01	0.00	0.002	0.004	0.003	0.01	0.01	0.01
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0086	0.0148	0.0116	0.43	0.74	0.58	0.0118	0.0252	0.0197	0.59	1.26	0.99
Total 10 PAHs	0.1630	0.2140	0.1846	0.16*	0.21*	0.18*	0.3111	0.3736	0.3484	0.31*	0.37*	0.35*
Total 7 PCBs	0.006	0.008	0.007	0.10	0.13	0.12	0.022	0.026	0.024	0.37	0.44	0.40
Manganese	128	146.0	137.4	0.09	0.10	0.09	69.9	172.1	121.0	0.05	0.11	0.08
Zinc	98.0	110	104.2	0.45	0.50	0.47	93.5	150.8	119.0	1.70	2.74	2.16
Copper	100	112	105.6	0.76	0.85	0.80	56.1	149.2	108.5	1.70	4.52	3.29
Nickel	25.1	29.3	27.0	0.31	0.37	0.34	18.4	29.8	24.9	0.92	1.49	1.25
Cobalt	3.1	3.7	3.4	0.16*	0.19*	0.17*	3.6	4.7	4.1	0.18*	0.24*	0.21*
Lead	60.7	62.8	61.8	1.90	1.96	1.93	47.6	108.7	81.9	1.49	3.40	2.56
Cadmium	0.03	0.06	0.05	0.02	0.03	0.02	0.03	0.07	0.05	0.06	0.13	0.10
Chrome	5.1	6.1	5.6	0.85	1.02	0.93	3.5	6.4	5.0	0.58	1.07	0.83
Mercury	0.01	0.03	0.018	0.00	0.01	0.01	0.039	0.054	0.044	0.02	0.03	0.02

Index	Point number											
	S01-007						S01-008					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	3670	7448	6136	73.4*	148. 96*	122.73*	7655	12430	9687	153.1*	248.6*	193.74*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	0.001	0.00	0.00	0.00
Toluene	<0.001	0.002	0.001	0.00	0.01	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.001	0.002	0.002	0.00	0.01	0.01	<0.001	0.002	0.001	0.00	0.01	0.00
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0045	0.0100	0.0074	0.23	0.50	0.37	0.0108	0.0162	0.0132	0.54	0.81	0.66
Total 10 PAHs	0.1909	0.2603	0.2170	0.19*	0.26*	0.22*	0.3193	0.3719	0.3500	0.32*	0.37*	0.35*
Total 7 PCBs	0.008	0.012	0.010	0.14	0.20	0.16	0.019	0.023	0.021	0.31	0.38	0.35
Manganese	121	185.7	153.8	0.08	0.12	0.10	38.7	92.2	68.6	0.03	0.06	0.05
Zinc	53.5	113.4	84.5	0.24	0.52	0.38	39.8	87.3	68.3	0.18	0.40	0.31
Copper	50	102.5	76.0	0.38	0.78	0.58	103.2	160.9	131.1	0.78	1.22	0.99
Nickel	17.4	30.1	22.1	0.22	0.38	0.28	22	33.9	28.7	0.28	0.42	0.36
Cobalt	3.9	5.3	4.7	0.20*	0.27*	0.23*	4.4	5.4	4.9	0.22*	0.27*	0.25*
Lead	55.5	86.8	71.9	1.73	2.71	2.25	49.3	74.0	58.4	1.54	2.31	1.83
Cadmium	0.04	0.06	0.05	0.02	0.03	0.02	0.03	0.06	0.05	0.01	0.03	0.02
Chrome	3.2	7.9	5.9	0.53	1.32	0.99	5.5	8.1	7.3	0.92	1.35	1.22
Mercury	0.037	0.051	0.041	0.02	0.02	0.02	0.038	0.048	0.042	0.02	0.02	0.02

Continuation of Table 5.3-11

Index	Point number											
	S01-009						S01-0010					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	3908	5806	4861	78.16*	116.12*	97.22*	5128	8266	6431	102.56*	165.32*	128.62*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00	<0.001	0.002	0.001	0.00	0.01	0.00
Toluene	<0.001	0.002	0.001	0.00	0.01	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.002	0.004	0.003	0.01	0.01	0.01	0.001	0.003	0.002	0.00	0.01	0.01
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0162	0.0208	0.0190	0.81	1.04	0.95	0.0479	0.0691	0.0571	2.40	3.46	2.86
Total 10 PAHs	0.4662	0.5865	0.5043	0.47*	0.59*	0.50*	0.7352	0.8501	0.7925	0.74*	0.85*	0.79*
Total 7 PCBs	0.020	0.023	0.022	0.33	0.39	0.37	0.008	0.010	0.009	0.13	0.17	0.15
Manganese	44.8	81.0	65.6	0.03	0.05	0.04	98.2	199.6	165.8	0.07	0.13	0.11
Zinc	54.0	113.4	93.8	0.98	2.06	1.71	67.3	174.4	126.3	0.31	0.79	0.57
Copper	48.3	122.5	87.8	1.46	3.71	2.66	68.4	152.6	112.3	0.52	1.16	0.85
Nickel	12.8	21.4	17.4	0.64	1.07	0.87	23.3	51.4	36.9	0.29	0.64	0.46
Cobalt	3.8	4.6	4.1	0.19*	0.23*	0.21*	3.7	5.2	4.3	0.19*	0.26*	0.22*
Lead	43.5	97.1	76.5	1.36	3.03	2.39	60.3	104.2	86.0	1.88	3.26	2.69
Cadmium	0.06	0.08	0.07	0.11	0.16	0.13	0.05	0.06	0.06	0.03	0.03	0.03
Chrome	3.8	8.6	6.7	0.63	1.43	1.12	3.6	5.4	4.5	0.60	0.90	0.74
Mercury	0.041	0.057	0.051	0.02	0.03	0.02	0.034	0.047	0.042	0.02	0.02	0.02

Index	Point number											
	S01-011						S01-012					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	60290	92160	77301	1205.8*	1843.2*	1546.02*	63967	91377	81093	1279.34*	1827.54*	1621.86*
Benzene	0.001	0.002	0.001	0.00	0.01	0.00	0.001	0.002	0.002	0.00	0.01	0.00
Toluene	0.001	0.002	0.002	0.00	0.01	0.01	0.001	0.003	0.002	0.00	0.01	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	<0.001	0.002	0.001	0.00	0.01	0.00	<0.001	0.002	0.002	0.00	0.01	0.00
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0796	0.1401	0.1137	3.98	7.01	5.69	0.1202	0.1619	0.1420	6.01	8.10	7.10
Total 10 PAHs	15.3553	19.1155	17.4634	15.36*	19.12*	17.46*	15.1351	16.8888	16.1523	15.14*	16.89*	16.15*
Total 7 PCBs	0.017	0.020	0.019	0.29	0.34	0.32	0.023	0.026	0.024	0.38	0.43	0.41
Manganese	95.3	100.2	97.6	0.06	0.07	0.07	72.4	131.3	104.0	0.05	0.09	0.07
Zinc	97.1	101.2	98.7	0.44	0.46	0.45	41.5	62.7	51.6	0.75	1.14	0.94
Copper	83.4	87.3	86.0	0.63	0.66	0.65	41.6	77.7	60.1	1.26	2.35	1.82
Nickel	21.9	25.9	23.9	0.27	0.32	0.30	7.8	18.3	14.0	0.39	0.92	0.70
Cobalt	5.2	7.2	6.4	0.26*	0.36*	0.32*	6.7	9.2	7.8	0.34*	0.46*	0.39*
Lead	28.2	34.3	31.7	0.88	1.07	0.99	33.6	51.9	44.1	1.05	1.62	1.38
Cadmium	0.02	0.08	0.06	0.01	0.04	0.03	0.06	0.11	0.10	0.13	0.22	0.19
Chrome	5.1	6.3	5.7	0.85	1.05	0.95	4.8	9.2	8.0	0.80	1.53	1.34
Mercury	0.010	0.060	0.024	0.00	0.03	0.01	0.028	0.039	0.034	0.01	0.02	0.02

Continuation of Table 5.3-11

Index	Point number					
	S01-013					
	Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.
Oil products	43862	109924	78015	877.24*	2198.48*	1560.31*
Benzene	0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.001	0.003	0.002	0.00	0.01	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.001	0.003	0.002	0.00	0.01	0.01
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.1164	0.2146	0.1775	5.82	10.73	8.88
Total 10 PAHs	15.8753	17.6033	16.7727	15.88*	17.60*	16.77*
Total 7 PCBs	0.026	0.031	0.029	0.43	0.52	0.48
Manganese	59.9	100.0	77.3	0.31	0.53	0.42
Zinc	67.1	116.6	92.4	0.42	0.90	0.64
Copper	55.1	119	84.2	0.15	0.42	0.28
Nickel	12.2	33.9	22.5	0.35	0.97	0.64
Cobalt	6.6	8.3	7.7	0.33*	0.42*	0.38*
Lead	17.5	35.3	27.3	0.55	1.10	0.85
Cadmium	0.06	0.08	0.07	0.03	0.04	0.04
Chrome	5.3	10.4	8.2	0.88	1.73	1.36
Mercury	0.026	0.034	0.030	0.01	0.02	0.01

The values of measured concentrations of indices to be monitored are given in summary tables in Appendix 3.

5.3.1.3 Comparative analysis of the level of contamination of the sites on Alexandra Island

A comparative analysis of soil contamination allows us to make the following conclusion:

- In terms of the content of **petroleum hydrocarbons**, the most contaminated soils are located in the vicinity of fuel and lubricant storage facility in Severnaya Bay (site 1), for which the average concentration of petroleum hydrocarbons **6.7 times** exceeds the intervention level according to international standards;
- Also site's 1 soils are the most contaminated with **polycyclic aromatic hydrocarbon** compounds. The average concentration of PAHs (in total) **8.8 times** exceeds the PC international standards, while in terms of the content of **benz(a)pyrene** the site's soils belong to the **hazardous contamination class** according to SanPiN 2.1.7.1287-03.
- The highest levels of the content of **polychlorinated biphenyls** were detected in soils in the vicinity of the radar station (site 9). At the same time, none of the surveyed sites had the average concentration of PCBs in soils reaching **MPC** and **PC** to correspond to the **permissible** contamination class according to SanPiN 2.1.7.1287-03.
- Among the surveyed areas, soils near the fuel and lubricant storage facility in the vicinity of the settlement of Nagurskoe (site 10) are the most contaminated with a series of heavy metals, which, using Zc index, belong to the **moderate hazardous contamination class** according to SanPiN 2.1.7.1287-03.

In general, the level of soil contamination at the surveyed sites can be assessed as follows:

- **extra-hazardous** for the radar station area (site 9);
- **extra-hazardous** for the fuel and lubricant storage facility near the settlement of Nagurskoe (site 10);
- **extra-hazardous** for the fuel and lubricant storage facility in Severnaya Bay (site 1).

Figure 5.3-13 shows the comparative analysis of the average content of pollutants in soils of the surveyed areas on Alexandra Island.

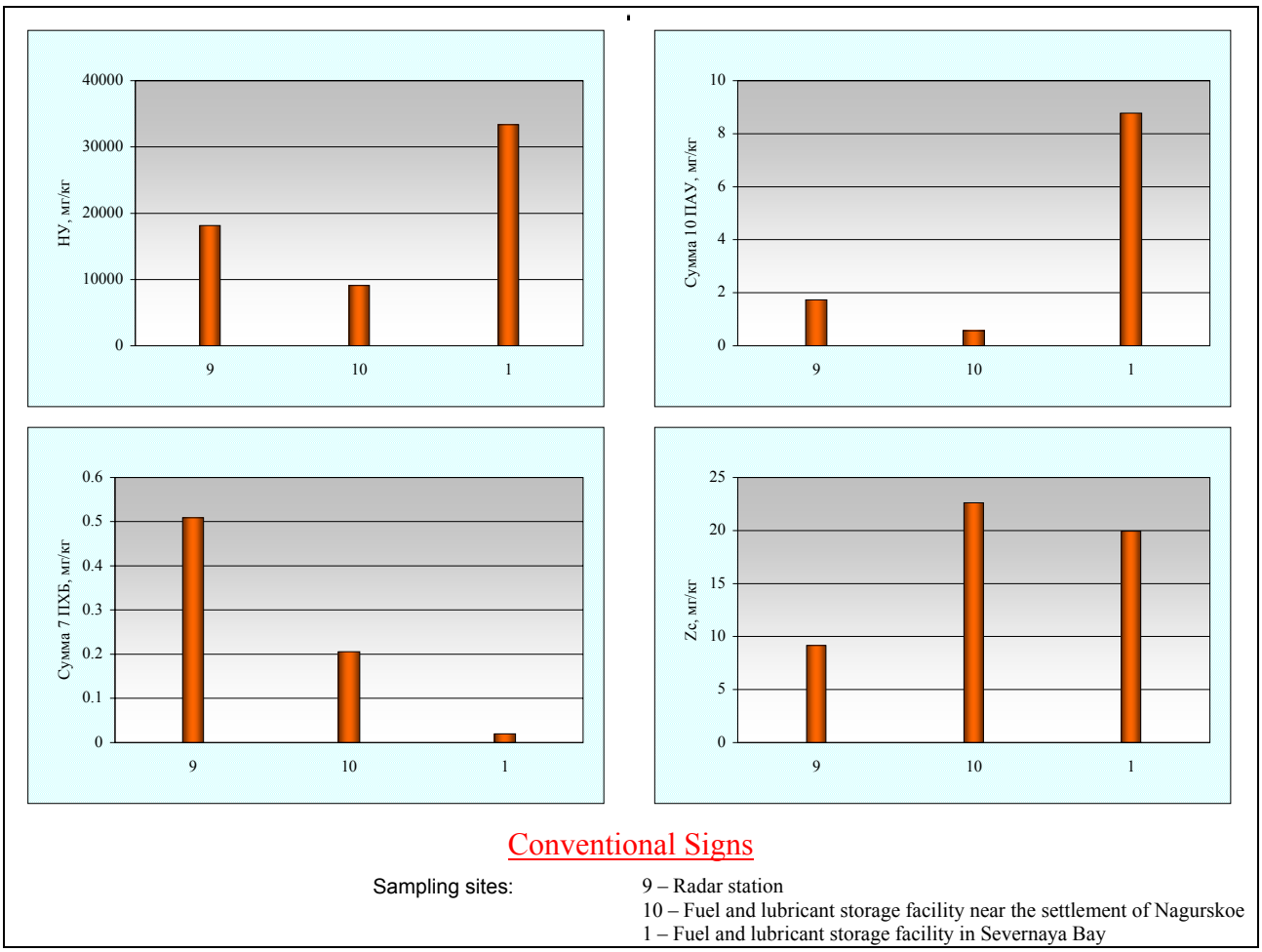


Figure 5.3-13 average values of the total pollution index Zc and average values petroleum hydrocarbons, PAH and PCB concentrations at the surveyed sites on Alexandra Island

5.3.2 Hoffman Island

5.3.2.1 Settlement (site 6)

50 soil samples at 10 points of geocological testing were collected **at site 6 on Hoffman Island (settlement)**

Assessment according to Russian standards

The content of VAH compounds in soils at the site did not exceed tenths of MPC and amounted to:

- benzene - 0.001 mg/kg (0.0 MPC units),
- toluene - 0.043 mg/kg (up to 0.14 MPC units)
- ∑ meta- and para-xylene - 0.0679 mg/kg (up to 0.23 MPC units),
- ortho-xylene - 0.0365 mg/kg (up to 0.12 MPC units),
- isopropylbenzene - 0.0092 mg/kg (up to 0.02 MPC units).

The content of benz(a)pyrene amounted to 0.7324 mg/kg (up to 36.61 MPC units, point S06-067).

The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents.

The content of heavy metals reached:

- manganese - 624 mg/kg (up to 0.42 MPC units, point S06-062);
- zinc - 387 mg/kg (up to 1.76 APC units, point S06-064);
- copper - 78.7 mg/kg (up to 0.77 APC units, point S06-067);
- nickel - 76.3 mg/kg (up to 1.28 APC units, point S06-067);
- lead - 62.0 mg/kg (up to 1.94 MPC units, point S06-070);
- chrome (mobile form) – 42.7 mg/kg (up to 7.12 MPC units, point S06-065);
- cadmium - 0.40 mg/kg (up to 0.20 APC units, point S06-066);
- mercury - 0.05 mg/kg (up to 0.02 MPC units, points S06-065, S06-066, S06-070).

The total PCB content reached up to 0.569 mg/kg (up to 0.95 APC units, point S06-063).

Intervals of pollutant content in soils at site's 6 points of geocological testing in mass concentration values and MPC, APC and PC units are given in Table 5.3-13 at the end of the Section

Table 5.3-12 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards.

Table 5.3-12 Assessment of the levels of soil contamination at the settlement area (site 6) according to SanPiN 2.1.7.1287-03 and international standards

Index	Site 6									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	17139							8.66	**1449.0***	**342.78***
Benzene	0.0010	0.00	0.00	0.00	permissible	permissible	permissible	0.00	0.03	0.02
Toluene	0.0143	0.00	0.14	0.05	permissible	permissible	permissible	0.00	0.09	0.03
Ethylbenzene	0.0051							0.04	0.27	0.10
∑ meta- and para-Xylene	0.0186	0.01	0.23	0.06	permissible	permissible	permissible	0.00	0.14	0.04
Ortho-Xylene	0.0089	0.01	0.12	0.03	permissible	permissible	permissible	0.01	0.07	0.02
Isopropylbenzene	0.0022	0.00	0.02	0.00	permissible	permissible	permissible			
Benz(a)pyrene	0.1044	0.15	36.61	5.22	permissible	extra-hazardous	extra-hazardous			
Total 10 PAHs	2.2630							0.34	17.03	2.26
Total 7 PCBs	0.0117	0.00	0.95	0.20	permissible	permissible	permissible	0.01	2.84	0.59
Manganese	261.3	0.08	0.42	0.17	permissible	permissible	permissible			
Zinc	124.0	0.02	1.76	0.62	permissible	extra-hazardous	permissible	0.04	2.76	0.89
Copper	34.4	0.12	0.77	0.30	permissible	permissible	permissible	0.36	2.19	0.96
Nickel	36.7	0.16	1.28	0.53	permissible	extra-hazardous	permissible	0.37	2.18	1.05
Cobalt	3.6							0.03	0.32	0.18
Lead	21.3	0.16	1.94	0.66	permissible	extra-hazardous	permissible	0.06	0.73	0.25
Cadmium	0.15	0.01	0.20	0.09	permissible	permissible	permissible	0.03	0.50	0.19
Chrome	24.2	1.47	7.12	4.03	hazardous	extra-hazardous	extra-hazardous	0.09	0.43	0.24
Mercury	0.029	0.00	0.02	0.01	permissible	permissible	permissible	0.03	0.17	0.10
Zc metals	17.32						moderately hazardous			

Note: * - values exceed the intervention level (IL)

In terms of the average content of volatile aromatic hydrocarbons, the total PCB, manganese, zinc, , copper, nickel, lead, cadmium, chrome and mercury, site's 6 soil belong to the **permissible** contamination class; in terms of the average content of **benz(a)pyrene** – to the **hazardous** contamination class.

The values of the total soil pollution index Zc calculated for a series of metals varied from 5.45 (**permissible** contamination class) to 27.08 (**moderately hazardous** contamination class), while the average value for the site was 17.32 (**moderately hazardous** contamination class). At the same time, at all testing points (except for S06-062, S06-069), the MPC or APC for zinc, nickel, lead, chrome and cadmium and Kmax values (according to Methodological Guidelines 2.1.7.730-99) were exceeded to correspond to the **extra-hazardous** soil contamination class.

In general, the level of soil contamination at the surveyed area of the radar station can be assessed as **extra-hazardous**

In general, the level of soil contamination at the surveyed area of the settlement can be assessed as **extra-hazardous**

Assessment according to international standards

Permissible concentrations (PC) of oil products, total PAHs, total PCBs, zinc, copper and nickel were exceeded in the site's soils at separate points, including:

- oil products - up to 1449 PC units;
- total PAHs - up to 17.03 PC units;
- total PCBs – up to 2.84 PC units;
- zinc - 2.76 PC units;
- copper - 2.19 PC units;
- nickel - 2.18 PC units.

In general, the average content of pollutants for the site exceeds the PC values as follows: oil products – 343 times; total PAHs – 1.7 times, total PAHs – 2.3 times and nickel – 1.1 times

It is necessary to pay special attention to the fact that the level of soil contamination with oil products at the site **exceeds the intervention level** both in the average value (3.4 times) and in the values at separate points of geocological testing (up to 14 IL)

Figures 5.3-14 – 5.3-17 show spatial characteristics of the level of site's 6 soil contamination with oil products, total PAHs, total PCBs in PC units and integrated pollution with heavy metals in Zc units

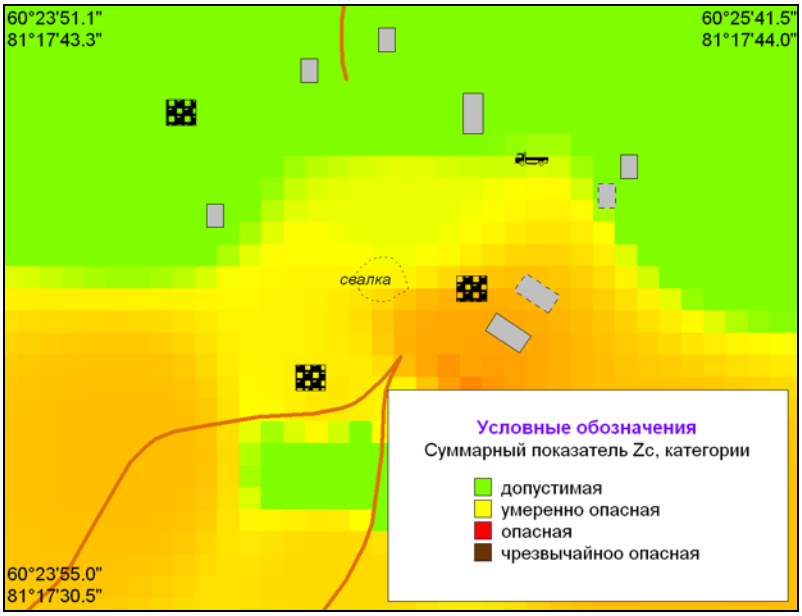


Figure5.3-14 Spatial characteristics of the level of soil contamination of the settlement area (site 6) with a series of heavy metals (Zc)

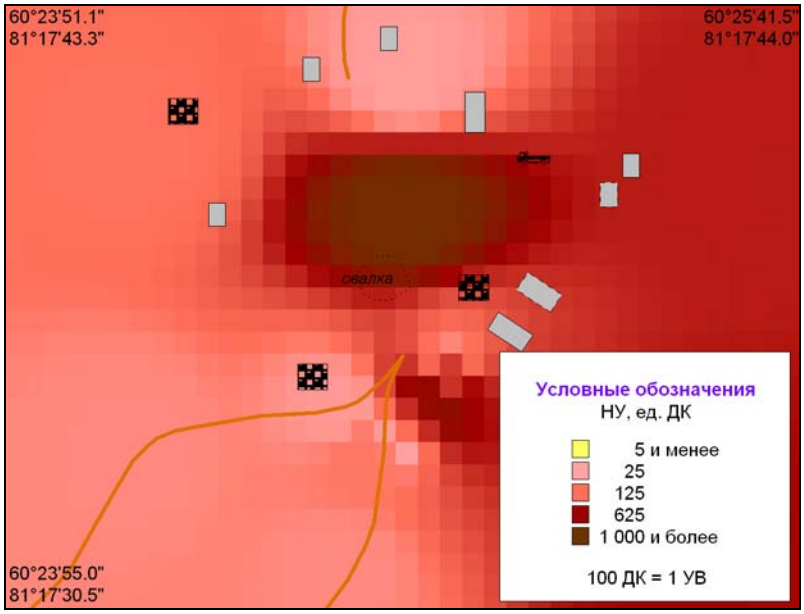
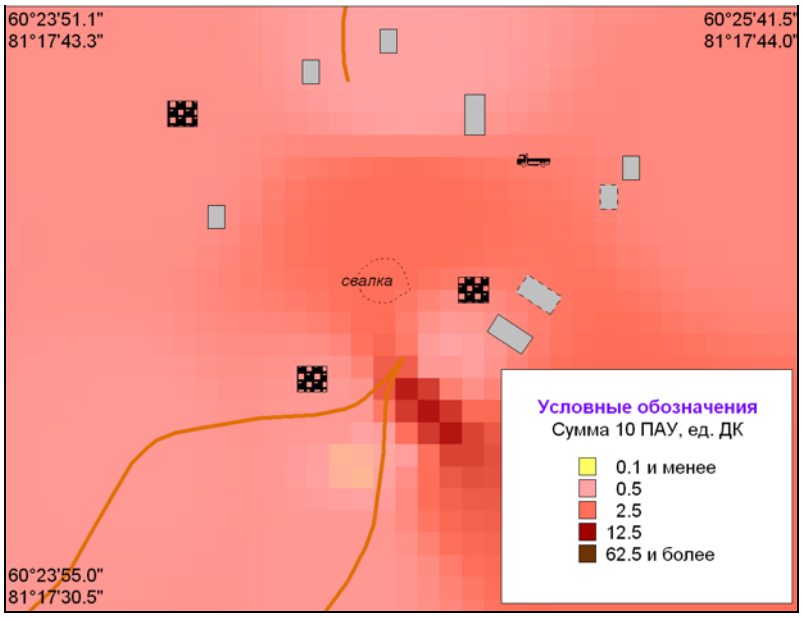
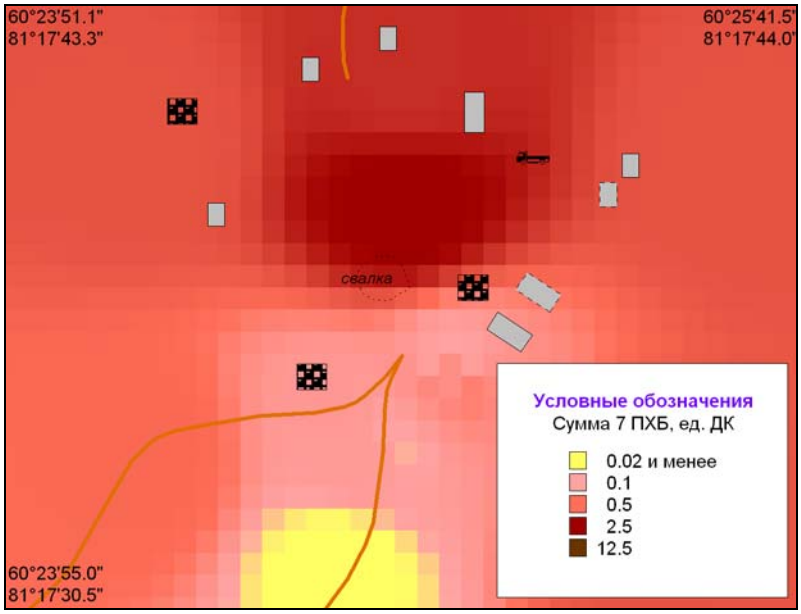


Figure5.3-15 Spatial characteristics of the level of soil contamination of the settlement area (site 6) with petroleum hydrocarbons (oil products)



Note: Total 10 PAHs - anthracene, benz(a)anthracene, benz(k)fluoranthene, benz(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(123cd)pyrene, naphthalene, benz(ghi)perylene)

Figure5.3-16 Spatial characteristics of the level of soil contamination of the settlement area (site 6) with polycyclic aromatic hydrocarbons



Note: Total 7 PCB - # 28, # 52, # 101, # 118, # 138, # 153, # 180

Figure5.3-17 Spatial characteristics of the level of soil contamination of the settlement area (site 6) with polychlorinated biphenyls

Table 5.3-13 Content of pollutants in the intervals of mass concentration and MPC, APC and PC units in soils at site's 6 points

Index	Point number											
	S06-062						S06-063					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	1008	3300	1816	20.16*	66.00*	36.32*	28460	64070	46976	569.20*	1281.40*	939.52*
Benzene	0.001	0.001	0.001	0.00	0.00	0.00	<0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.013	0.016	0.015	0.04	0.05	0.05	0.009	0.012	0.010	0.03	0.04	0.03
Ethylbenzene	0.003	0.005	0.004	0.05*	0.10*	0.08*	0.002	0.004	0.003	0.04*	0.07*	0.06*
∑ meta- and para-Xylene	0.008	0.014	0.011	0.03	0.05	0.04	0.012	0.016	0.014	0.04	0.05	0.05
Ortho-Xylene	0.004	0.007	0.006	0.01	0.02	0.02	0.004	0.006	0.005	0.01	0.02	0.02
Isopropylbenzene	0.001	0.003	0.002	0.00	0.01	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0209	0.0384	0.0290	1.05	1.92	1.45	0.1980	0.3761	0.3032	9.90	18.81	15.16
Total 10 PAHs	0.4178	0.6169	0.5455	0.42*	0.62*	0.55*	2.3448	2.6658	2.4999	2.34*	2.67*	2.50*
Total 7 PCBs	0.030	0.036	0.034	0.50	0.60	0.56	0.045	0.057	0.051	0.75	0.95	0.85
Manganese	511	624.0	573.6	0.34	0.42	0.38	127	172.0	150.0	0.08	0.11	0.10
Zinc	5.2	13.1	8.4	0.02	0.06	0.04	43.5	94.2	74.2	0.20	0.43	0.34
Copper	19.4	26.3	22.5	0.15	0.20	0.17	39.2	74.6	58.7	0.30	0.57	0.45
Nickel	27	34.9	30.7	0.34	0.44	0.38	18.6	26.6	22.9	0.23	0.33	0.29
Cobalt	4.6	5.3	4.9	0.23*	0.27*	0.25*	2.6	3.3	2.9	0.13*	0.17*	0.15
Lead	9.5	13.4	11.3	0.30	0.42	0.35	15.2	38.6	30.5	0.48	1.21	0.95
Cadmium	0.10	0.30	0.18	0.05	0.15	0.09	0.10	0.20	0.18	0.05	0.10	0.09
Chrome	26.1	39.8	32.3	4.35	6.63	5.38	18.6	26.5	21.1	3.10	4.42	3.51
Mercury	0.03	0.05	0.040	0.01	0.02	0.02	0.02	0.02	0.020	0.01	0.01	0.01

Index	Point number											
	S06-064						S06-065					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	1553	4328	3109	31.06*	86.56*	62.18*	47160	72450	59850	943.20*	1449.00*	1197.00*
Benzene	0.001	0.001	0.001	0.00	0.00	0.00	0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.009	0.014	0.011	0.03	0.05	0.04	0.011	0.014	0.013	0.04	0.05	0.04
Ethylbenzene	0.003	0.004	0.004	0.06*	0.08*	0.07*	0.006	0.008	0.007	0.13*	0.16*	0.14*
∑ meta- and para-Xylene	0.012	0.018	0.015	0.04	0.06	0.05	0.013	0.017	0.014	0.04	0.06	0.05
Ortho-Xylene	0.004	0.005	0.004	0.01	0.02	0.01	0.007	0.008	0.007	0.02	0.03	0.02
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.003	0.004	0.004	0.01	0.01	0.01
Benz(a)pyrene	0.0030	0.0052	0.0043	0.15	0.26	0.22	0.0468	0.0973	0.0762	2.34	4.87	3.81
Total 10 PAHs	0.3597	0.5330	0.4499	0.36*	0.53*	0.45*	1.1431	1.3560	1.2847	1.14*	1.36*	1.28*
Total 7 PCBs	0.002	0.002	0.002	0.03	0.04	0.03	0.011	0.012	0.011	0.18	0.20	0.19
Manganese	158.5	209.0	190.1	0.11	0.14	0.13	200	265.0	221.6	0.13	0.18	0.15
Zinc	280.7	387	338.4	1.28	1.76	1.54	85.7	134.6	123.0	0.39	0.61	0.56
Copper	17.5	35.2	28.2	0.13	0.27	0.21	28.1	65.3	47.7	0.21	0.49	0.36
Nickel	13	24.3	18.1	0.16	0.30	0.23	33.7	47.4	38.9	0.42	0.59	0.49
Cobalt	4.1	5.4	4.6	0.21*	0.27*	0.23*	2.4	3.2	2.8	0.12*	0.16*	0.14*
Lead	14	24.9	20.5	0.44	0.78	0.64	9.5	19.6	16.4	0.30	0.61	0.51
Cadmium	0.10	0.10	0.10	0.05	0.05	0.05	0.10	0.30	0.20	0.05	0.15	0.10
Chrome	21.7	31.4	25.9	3.62	5.23	4.31	34.9	42.7	39.9	5.82	7.12	6.65
Mercury	0.01	0.01	0.010	0.00	0.00	0.00	0.04	0.05	0.048	0.02	0.02	0.02

Continuation of Table 5.3-13

Index	Point number											
	S06-066						S06-067					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	4840	6812	5822	96.80*	136.24*	116.44*	32030	50760	42076	640.60*	1015.20*	841.52*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00	0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.001	0.003	0.002	0.00	0.01	0.01	0.037	0.043	0.041	0.12	0.14	0.14
Ethylbenzene	0.003	0.004	0.003	0.05*	0.08*	0.06*	0.008	0.012	0.010	0.16*	0.24*	0.19*
∑ meta- and para-Xylene	0.003	0.004	0.004	0.01	0.01	0.01	0.049	0.054	0.052	0.16	0.18	0.17
Ortho-Xylene	0.003	0.005	0.004	0.01	0.02	0.01	0.014	0.021	0.017	0.05	0.07	0.06
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.006	0.007	0.007	0.01	0.01	0.01
Benz(a)pyrene	0.0113	0.0178	0.0150	0.57	0.89	0.75	0.4232	0.7321	0.5805	21.16	36.61	29.03
Total 10 PAHs	0.7522	1.2086	1.0315	0.75*	1.21*	1.03*	11.2607	17.0287	14.0891	11.26*	17.03*	14.09*
Total 7 PCBs	0.004	0.007	0.005	0.07	0.11	0.09	0.004	0.006	0.005	0.07	0.10	0.08
Manganese	391	537.0	434.0	0.26	0.36	0.29	130.3	167.0	144.7	0.09	0.11	0.10
Zinc	203.6	277.6	241.8	0.93	1.26	1.10	8.4	13	10.7	0.04	0.06	0.05
Copper	18.8	29.8	22.9	0.14	0.23	0.17	31	78.7	55.5	0.23	0.60	0.42
Nickel	45.5	64	54.2	0.57	0.80	0.68	36.3	76.3	57.8	0.45	0.95	0.72
Cobalt	0.9	1.1	1.0	0.05*	0.06*	0.05*	4.6	6.3	5.2	0.23*	0.32*	0.26*
Lead	34.5	53.0	42.0	1.08	1.66	1.31	5.1	12.8	10.3	0.16	0.40	0.32
Cadmium	0.20	0.40	0.30	0.10	0.20	0.15	0.10	0.10	0.10	0.05	0.05	0.05
Chrome	8.8	16.4	13.6	1.47	2.73	2.27	10.4	16.8	15.2	1.73	2.80	2.54
Mercury	0.04	0.05	0.044	0.02	0.02	0.02	0.02	0.03	0.022	0.01	0.01	0.01

Index	Point number											
	S06-068						S06-069					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	433	662	533	8.66*	13.24*	10.67*	4651	6139	5440	93.02*	122.78*	108.80*
Benzene	0.001	0.001	0.001	0.00	0.00	0.00	0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.040	0.042	0.041	0.13	0.14	0.14	0.006	0.008	0.007	0.02	0.03	0.02
Ethylbenzene	0.009	0.013	0.011	0.17*	0.27*	0.21*	0.003	0.004	0.003	0.05*	0.08*	0.07*
∑ meta- and para-Xylene	0.028	0.068	0.051	0.09	0.23	0.17	0.017	0.024	0.020	0.06	0.08	0.07
Ortho-Xylene	0.020	0.037	0.027	0.07	0.12	0.09	0.011	0.016	0.013	0.04	0.05	0.04
Isopropylbenzene	0.007	0.009	0.008	0.01	0.02	0.02	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0029	0.0046	0.0036	0.15	0.23	0.18	0.0084	0.0112	0.0094	0.42	0.56	0.47
Total 10 PAHs	0.3394	0.5658	0.4788	0.34*	0.57*	0.48*	0.3462	0.4508	0.4037	0.35*	0.45*	0.40*
Total 7 PCBs	0.001	0.002	0.002	0.02	0.03	0.03	0.003	0.004	0.003	0.05	0.06	0.06
Manganese	174	234.0	203.8	0.12	0.16	0.14	145	210.0	172.7	0.10	0.14	0.12
Zinc	116.0	168	139.6	0.53	0.76	0.63	23.8	53	40.5	0.43	0.96	0.74
Copper	27.1	41.3	35.3	0.21	0.31	0.27	12.8	25.3	19.0	0.39	0.77	0.58
Nickel	48.7	62.5	54.4	0.61	0.78	0.68	14.6	25.5	19.7	0.73	1.28	0.99
Cobalt	3.4	5.5	4.4	0.17*	0.28*	0.22*	0.6	0.8	0.7	0.03*	0.04*	0.03*
Lead	8.2	18.3	13.5	0.26	0.57	0.42	5.9	12.0	9.5	0.18	0.38	0.30
Cadmium	0.02	0.06	0.04	0.01	0.03	0.02	0.10	0.10	0.10	0.20	0.20	0.20
Chrome	19.1	26.4	21.8	3.18	4.40	3.63	15.1	22.2	18.6	2.52	3.70	3.10
Mercury	0.01	0.03	0.018	0.00	0.01	0.01	0.02	0.02	0.020	0.01	0.01	0.01

Continuation of Table 5.3-13

Index	Point number											
	S06-070						S06-071					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	2835	4466	3685	56.70*	89.32*	73.69*	1259	3118	2082	25.18*	62.36*	41.64*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.001	0.001	0.001	0.00	0.00	0.00
Toluene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Ethylbenzene	0.002	0.004	0.003	0.04*	0.08*	0.07*	0.003	0.004	0.004	0.05*	0.09*	0.07*
∑ meta- and para-Xylene	0.002	0.004	0.003	0.01	0.01	0.01	0.002	0.004	0.003	0.01	0.01	0.01
Ortho-Xylene	0.003	0.005	0.003	0.01	0.02	0.01	0.003	0.004	0.003	0.01	0.01	0.01
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.001	0.002	0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0095	0.0137	0.0117	0.48	0.69	0.58	0.0072	0.0135	0.0114	0.36	0.68	0.57
Total 10 PAHs	0.7658	1.0870	0.9519	0.77*	1.09*	0.95*	0.7314	1.0437	0.8952	0.73*	1.04*	0.90*
Total 7 PCBs	0.000	0.000	0.000	0.00	0.00	0.00	0.003	0.004	0.004	0.05	0.07	0.06
Manganese	296.3	394.0	340.7	0.20	0.26	0.23	148.1	196.0	181.6	0.10	0.13	0.12
Zinc	59.3	99.2	81.1	0.27	0.45	0.37	119.6	233.3	181.9	0.54	1.06	0.83
Copper	20.4	40.6	29.6	0.15	0.31	0.22	15.9	32.3	24.4	0.12	0.24	0.18
Nickel	21	40.3	31.5	0.26	0.50	0.39	29.2	50.6	38.6	0.37	0.63	0.48
Cobalt	3.9	5.8	4.5	0.20*	0.29*	0.23*	3.9	5.3	4.6	0.20*	0.27*	0.23*
Lead	34.3	62.0	48.8	1.07	1.94	1.52	6.8	11.8	9.8	0.21	0.37	0.31
Cadmium	0.10	0.20	0.18	0.05	0.10	0.09	0.10	0.10	0.10	0.05	0.05	0.05
Chrome	13.4	24.7	21.1	2.23	4.12	3.51	24.4	39.9	32.1	4.07	6.65	5.35
Mercury	0.04	0.05	0.042	0.02	0.02	0.02	0.02	0.03	0.024	0.01	0.01	0.01

The values of measured concentrations of soil indices to be monitored are given in summary tables in Appendix 3.

5.3.2.2 Drum storage facility on the glacier (site 7)

30 soil samples at 6 points of geocological testing were collected **at site 7 on Hoffman Island (drum storage facility on the glacier)**

Assessment according to Russian standards

The content of VAH compounds in soils at the site did not exceed tenths of MPC and amounted to:

- benzene - 0.003 mg/kg (up to 0.01 MPC units);
- toluene - 0.003 mg/kg (up to 0.01 MPC units);
- ∑ meta- and para-xylene - 0.005 mg/kg (up to 0.02 MPC units);
- ortho-xylene - 0.007 mg/kg (up to 0.02 MPC units);
- isopropylbenzene - 0.001 mg/kg (0.00 MPC units).

The content of benz(a)pyrene amounted to 0.1071 mg/kg (up to 5.36 MPC units, point S07-07).

The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents.

The content of heavy metals reached:

- manganese - 509 mg/kg (up to 0.34 MPC units, point S07-074);
- zinc - 448 mg/kg (up to 4.07 APC units, point S07-075);
- copper - 123 mg/kg (up to 1.86 APC units, point S07-075);
- nickel - 76.9 mg/kg (up to 1.92 APC units, point S07-074);
- lead - 57.5 mg/kg (up to 1.80 MPC units, point S07-076);
- chrome (mobile form) – 54.7 mg/kg (up to 9.12 MPC units, point S07-077);
- cadmium - 0.40 mg/kg (up to 0.40 APC units, points S07-074, S07-077);
- mercury - 0.06 mg/kg (up to 0.03 MPC units, points S07-074, S07-077).

The total PCB content reached up to 0.245 mg/kg (up to 4 APC units, point S09-082).

Intervals of pollutant content in soils at site's 7 points of geocological testing in mass concentration values and MPC, APC and PC units are given in Table 5.3-15 at the end of the Section

Table 5.3-14 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards

Table 5.3-14 Assessment of the levels of soil contamination at drum storage facility on the glacier area (site 7) according to SanPiN 2.1.7.1287-03 and international standards

Index	Site 7									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min
Oil products	2730							21.78	**106.64***	54.60
Benzene	0.002	0.00	0.01	0.01	permissible	permissible	permissible	0.03	0.06	0.04
Toluene	0.002	0.00	0.01	0.01	permissible	permissible	permissible	0.00	0.01	0.00
Ethylbenzene	<0.001							0.00	0.04	0.01
∑ meta- and para-Xylene	0.002	0.00	0.02	0.01	permissible	permissible	permissible	0.00	0.01	0.00
Ortho-Xylene	0.003	0.00	0.02	0.01	permissible	permissible	permissible	0.00	0.01	0.01
Isopropylbenzene	<0.001	0.00	0.00	0.00	permissible	permissible	permissible			
Benz(a)pyrene	0.0615	1.08	5.36	3.08	permissible	extra-hazardous	hazardous			
Total 10 PAHs	0.4312							0.31	0.55	0.43
Total 7 PCBs	0.017	0.06	1.50	0.29	permissible	permissible	permissible	0.17	4.49	0.86
Manganese	230.1	0.05	0.34	0.15	permissible	permissible	permissible			
Zinc	147.0	0.07	4.07	1.16	permissible	extra-hazardous	extra-hazardous	0.10	3.20	1.05
Copper	48.0	0.14	1.86	0.60	permissible	extra-hazardous	permissible	0.50	3.42	1.33
Nickel	27.1	0.17	1.92	0.54	permissible	extra-hazardous	permissible	0.38	2.20	0.77
Cobalt	2.7							0.03	0.27	0.13
Lead	31.2	0.32	1.80	0.97	permissible	extra-hazardous	permissible	0.12	0.68	0.37
Cadmium	0.21	0.00	0.40	0.17	permissible	permissible	permissible	0.08	0.50	0.26
Chrome	22.8	1.05	9.12	3.79	xtra-hazardou	extra-hazardous	extra-hazardous	0.06	0.55	0.23
Mercury	0.030	0.00	0.03	0.01	permissible	permissible	permissible	0.03	0.20	0.10
Zc metals	19.33						moderately hazardous			

Note: * - values exceed the intervention level (IL)

In terms of the average content of volatile aromatic hydrocarbons, manganese, copper, nickel, lead, cadmium and mercury, site's 7 soil belong to the **permissible** contamination class; in terms of the average content of **benz(a)pyrene** – to the **hazardous** contamination class; in terms of the content of **zinc –** to the **extra-hazardous** contamination class

The values of the total soil pollution index Zc calculated for a series of metals varied from 5.16 (**permissible** contamination class) to 19.33 (**hazardous** contamination class), while the average value for the site was 22.6 (**moderately hazardous** contamination class)

At the same time, at all testing points (except for S07-073), in part of samples, the MPC or APC for zinc, copper, nickel, lead, chrome and cadmium and Kmax values (according to Methodological Guidelines 2.1.7.730-99) were exceeded to correspond to the **extra-hazardous** soil contamination class.

In general, the level of soil contamination at the surveyed area of the drum storage facility on the glacier can be assessed as **extra-hazardous**

Assessment according to international standards

Permissible concentrations (PC) of oil products, total PAHs, zinc, copper and nickel were exceeded in the site's soils at separate points, including:

- oil products - up to 106.64 PC units;
- total PCBs – up to 4.49 PC units;
- zinc - up to 3.20 PC units;
- copper - up to 3.42 PC units;
- nickel - up to 2.20 PC units;

In general, the average content of pollutants for the site exceeds the PC values as follows: oil products – 54.6 times; zinc – 1. 1 times and copper – 1.3 times

It is necessary to pay special attention to the fact that the level of soil contamination with oil products at the site **exceeds the intervention level** both in the average value (3.6 times) and in the values at separate points of geocological testing (up to 1.1 IL).

Figures 5.3-18 – 5.3-21 show spatial characteristics of the level of site's 7 soil contamination with oil products, total PAHs, total PCBs in PC units and integrated pollution with heavy metals in Zc units.

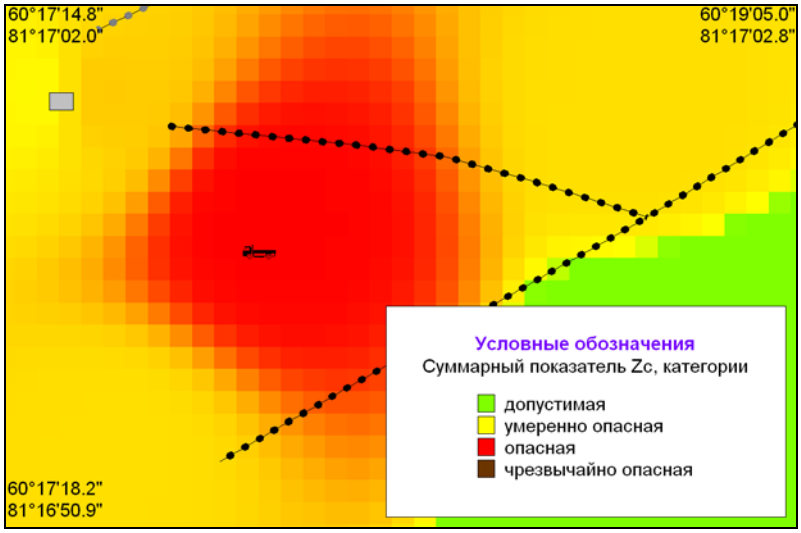


Figure 5.3-18 Spatial characteristics of the level of soil contamination of the drum storage facility on the glacier area (site 7) with a series of heavy metals (Zc)

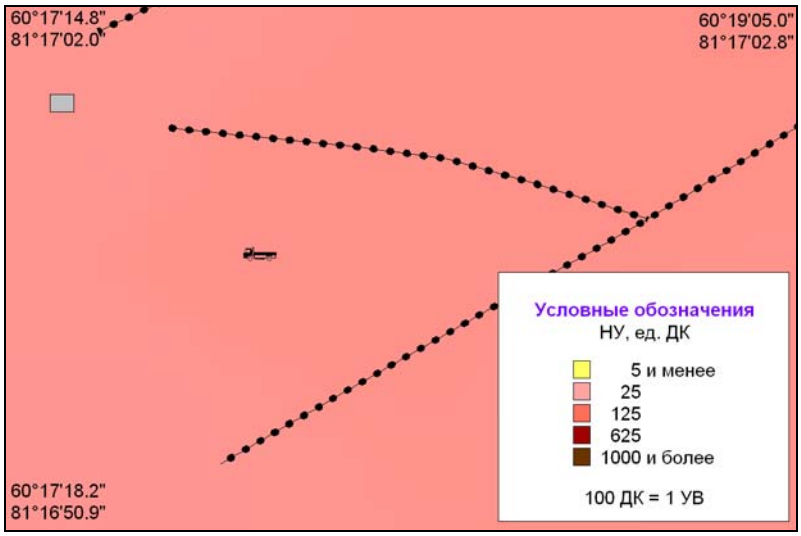
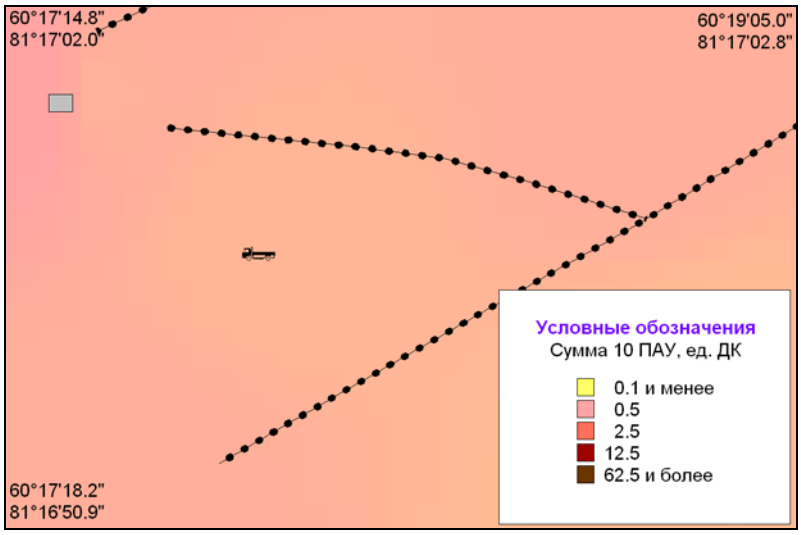
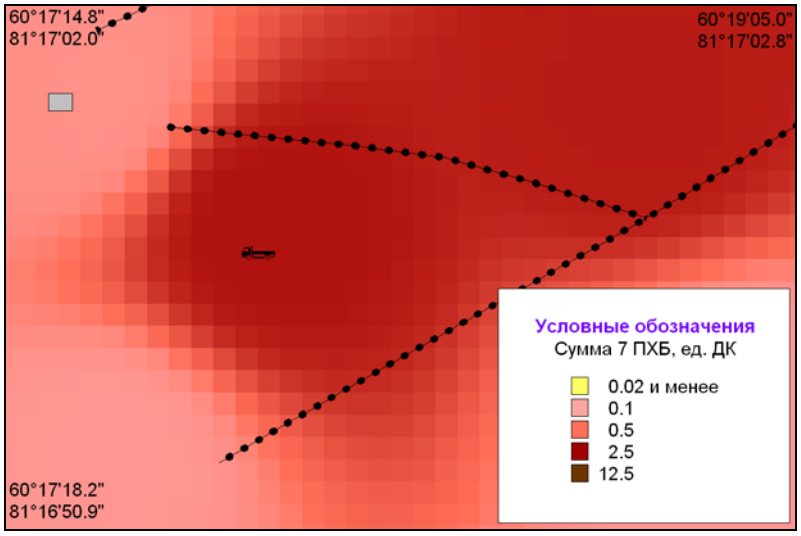


Figure 5.3-19 Spatial characteristics of the level of soil contamination of the drum storage facility on the glacier area (site 7) with petroleum hydrocarbons (oil products)



Note: Total 10 PAHs - anthracene, benz(a)anthracene, benz(k)fluoranthene, benz(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(123cd)pyrene, naphthalene, benz(ghi)perylene)

Figure 5.3-20 Spatial characteristics of the level of soil contamination of the drum storage facility on the glacier area (site 7) with polycyclic aromatic hydrocarbons



Note: Total 7 PCB - # 28, # 52, # 101, # 118, # 138, # 153, # 180

Figure 5.3-21 Spatial characteristics of the level of soil contamination of the drum storage facility on the glacier area (site 7) with polychlorinated biphenyls

Table 5.3-15 Content of pollutants in the intervals of mass concentration and MPC, APC and PC units in soils at site's 7 points

Index	Point number											
	S07-072						S07-073					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	1498	4873	2612	29.96*	97.46*	52.24*	1089	4268	2845	21.78*	85.36*	56.90*
Benzene	0.001	0.002	0.002	0.00	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Toluene	0.001	0.002	0.001	0.00	0.01	0.00	0.001	0.002	0.002	0.00	0.01	0.01
Ethylbenzene	<0.001	0.001	0.001	0.00*	0.02*	0.02*	0.001	0.002	0.002	0.02*	0.04*	0.03*
∑ meta- and para-Xylene	<0.001	0.001	0.001	0.00	0.00	0.00	0.002	0.004	0.003	0.01	0.01	0.01
Ortho-Xylene	0.002	0.002	0.002	0.01	0.01	0.01	0.003	0.004	0.003	0.01	0.01	0.01
Isopropylbenzene	<0.001	0.001	0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0546	0.0936	0.0753	2.73	4.68	3.76	0.0537	0.0919	0.0702	2.69	4.60	3.51
Total 10 PAHs	0.3817	0.4202	0.3972	0.38*	0.42*	0.40*	0.3142	0.4396	0.3936	0.31*	0.44*	0.39*
Total 7 PCBs	0.003	0.004	0.004	0.06	0.07	0.06	0.004	0.004	0.004	0.06	0.07	0.07
Manganese	84	137.0	107.5	0.06	0.09	0.07	200	294.0	246.0	0.13	0.20	0.16
Zinc	68.1	158.3	126.5	0.31	0.72	0.58	14.6	31.6	21.4	0.07	0.14	0.10
Copper	22.2	53.8	38.1	0.17	0.41	0.29	17.9	27.1	22.5	0.14	0.21	0.17
Nickel	19.5	29	22.4	0.24	0.36	0.28	13.2	22.1	17.8	0.17	0.28	0.22
Cobalt	2.8	3.7	3.1	0.14*	0.19*	0.16*	2.3	2.8	2.5	0.12	0.14	0.13
Lead	12.1	28.9	20.8	0.38	0.90	0.65	10.3	18.6	15.2	0.32	0.58	0.47
Cadmium	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.05	0.05	0.05
Chrome	12.8	21.3	18.1	2.13	3.55	3.01	6.3	12.2	9.1	1.05	2.03	1.52
Mercury	0.01	0.01	0.010	0.00	0.00	0.00	0.01	0.01	0.010	0.00	0.00	0.00

Index	Point number											
	S07-074						S07-075					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	1277	2347	1827	25.54*	46.94*	36.55*	2440	5332	3902	48.80*	106.64*	78.05*
Benzene	0.002	0.003	0.002	0.01	0.01	0.01	0.002	0.003	0.002	0.01	0.01	0.01
Toluene	0.002	0.003	0.002	0.01	0.01	0.01	0.002	0.003	0.002	0.01	0.01	0.01
Ethylbenzene	<0.001	0.002	0.001	0.02*	0.03*	0.03*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.003	0.005	0.004	0.01	0.02	0.01	<0.001	0.001	0.001	0.00	0.00	0.00
Ortho-Xylene	0.005	0.007	0.006	0.02	0.02	0.02	0.002	0.002	0.002	0.01	0.01	0.01
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0215	0.0329	0.0274	1.08	1.65	1.37	0.0516	0.0721	0.0611	2.58	3.61	3.05
Total 10 PAHs	0.4422	0.5213	0.4796	0.44*	0.52*	0.48*	0.3272	0.3922	0.3603	0.33*	0.39*	0.36*
Total 7 PCBs	0.004	0.005	0.004	0.06	0.08	0.07	0.073	0.090	0.081	1.21	1.50	1.35
Manganese	303	509.0	398.9	0.20	0.34	0.27	73.6	111.0	92.8	0.05	0.07	0.06
Zinc	195.8	324.7	251.8	1.78	2.95	2.29	274.0	448	345.0	2.49	4.07	3.14
Copper	39.7	99.7	67.8	0.60	1.51	1.03	75.4	123	90.5	1.14	1.86	1.37
Nickel	32.3	76.9	56.0	0.81	1.92	1.40	16.9	24.6	19.8	0.42	0.62	0.50
Cobalt	4.3	5.4	4.9	0.22*	0.27*	0.25*	0.6	1.1	0.8	0.03*	0.06*	0.04*
Lead	17.3	39.7	31.6	0.54	1.24	0.99	30.7	46.9	37.5	0.96	1.47	1.17
Cadmium	0.30	0.40	0.32	0.30	0.40	0.32	0.10	0.30	0.24	0.10	0.30	0.24
Chrome	20.9	33.5	26.3	3.48	5.58	4.38	9.1	14	11.7	1.52	2.33	1.94
Mercury	0.04	0.06	0.048	0.02	0.03	0.02	0.01	0.02	0.014	0.00	0.01	0.01

Continuation of Table 5.3-15

Index	Point number											
	S07-076						S07-077					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	1658	3368	2535	33.16*	67.36*	50.70*	1783	4437	2659	35.66*	88.74*	53.17*
Benzene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.003	0.002	0.01	0.01	0.01
Toluene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.003	0.003	0.01	0.01	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	<0.001	0.002	0.001	0.00	0.01	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ortho-Xylene	0.001	0.002	0.002	0.00	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0409	0.0613	0.0508	2.05	3.07	2.54	0.0529	0.1071	0.0844	2.65	5.36	4.22
Total 10 PAHs	0.3831	0.5080	0.4403	0.38*	0.51*	0.44*	0.4769	0.5535	0.5160	0.48*	0.55*	0.52*
Total 7 PCBs	0.004	0.005	0.005	0.07	0.09	0.08	0.004	0.005	0.005	0.07	0.09	0.08
Manganese	285	460.0	370.4	0.19	0.31	0.25	92	244.0	165.1	0.06	0.16	0.11
Zinc	61.3	99.3	82.0	0.28	0.45	0.37	33.5	73.6	55.3	0.30	0.67	0.50
Copper	21.1	58	38.6	0.16	0.44	0.29	20	37.3	30.4	0.30	0.57	0.46
Nickel	22.7	31.3	27.6	0.28	0.39	0.35	14.5	21.2	18.8	0.36	0.53	0.47
Cobalt	1.7	2.3	2.0	0.09*	0.12*	0.10*	2	2.8	2.5	0.10*	0.14*	0.13*
Lead	36.5	57.5	46.3	1.14	1.80	1.45	18.7	41.8	35.5	0.58	1.31	1.11
Cadmium	0.10	0.20	0.18	0.05	0.10	0.09	0.30	0.40	0.32	0.30	0.40	0.32
Chrome	21.2	35.5	27.6	3.53	5.92	4.60	27	54.7	43.8	4.50	9.12	7.30
Mercury	0.04	0.05	0.046	0.02	0.02	0.02	0.05	0.06	0.054	0.02	0.03	0.03

The values of measured concentrations of soil indices to be monitored are given in summary tables in Appendix 3.

5.3.2.3 Drum storage facility on the coast (site 8)

5 soil samples at 1 point of geocological testing were collected **at site 8 on Hoffman Island (drum storage facility on the coast)**

Assessment according to Russian standards

The content of VAH compounds in soils at the site did not exceed tenths of MPC and amounted to:

- benzene - 0.002 mg/kg (up to 0.01 MPC units);
- toluene - 0.002 mg/kg (up to 0.01 MPC units);
- ∑ meta- and para-xylene - 0.002 mg/kg (up to 0.01 MPC units);
- ortho-xylene - 0.001 mg/kg (up to 0.005 MPC units);
- isopropylbenzene - all values were below the lowest detection limit of the analysis technique.

The content of benz(a)pyrene amounted to 0.056 mg/kg (up to 2.80 APC units).

The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents.

The content of heavy metals reached:

- manganese - 489 mg/kg (up to 0.33 MPC units);
- zinc - 96.1 mg/kg (up to 0.44 APC units);
- copper - 124.8 mg/kg (up to 0.94 APC units);
- nickel - 63.3 mg/kg (up to 0.79 APC units);
- lead - 15.7 mg/kg (up to 0.49 MPC units);
- chrome (mobile form) – 41.4 mg/kg (up to 6.9 MPC units);
- cadmium - 0.30 mg/kg (up to 0.15 APC units);
- mercury - 0.03 mg/kg (up to 0.01 MPC units).

The total PCB content reached up to 0.031 mg/kg (up 0.09 APC units)

Table 5.3-16 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards

Table 5.3-16 Assessment of the levels of soil contamination at drum storage facility on the coast area (site 8) according to SanPiN 2.1.7.1287-03 and international standards

Index	Site 8									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	4192							59.18	**106.04***	83.84
Benzene	0.002	0.01	0.01	0.01	permissible	permissible	permissible	0.03	0.04	0.03
Toluene	0.002	0.01	0.01	0.01	permissible	permissible	permissible	0.00	0.00	0.00
Ethylbenzene	<0.001							0.00	0.00	0.00
∑ meta- and para-Xylene	0.001	0.00	0.01	0.00	permissible	permissible	permissible	0.00	0.00	0.00
Ortho-Xylene	0.001	0.00	0.00	0.00	permissible	permissible	permissible	0.00	0.00	0.00
Isopropylbenzene	<0.001	0.00	0.00	0.00	permissible	permissible	permissible			
Benz(a)pyrene	0.0471	1.96	2.80	2.36	permissible	hazardous	hazardous			
Total 10 PAHs	0.344							0.31	0.37	0.34
Total 7 PCBs	0.005	0.07	0.09	0.08	permissible	permissible	permissible	0.22	0.27	0.25
Manganese	341.2	0.16	0.33	0.23	permissible	permissible	permissible			
Zinc	68.8	0.21	0.44	0.31	permissible	permissible	permissible	0.32	0.69	0.49
Copper	86.5	0.36	0.94	0.66	permissible	permissible	permissible	1.33	3.46	2.40
Nickel	49.4	0.42	0.79	0.62	permissible	permissible	permissible	0.95	1.81	1.41
Cobalt	1.4							0.06	0.08	0.07
Lead	13.9	0.37	0.49	0.44	permissible	permissible	permissible	0.14	0.18	0.16
Cadmium	0.28	0.10	0.15	0.14	permissible	permissible	permissible	0.25	0.38	0.35
Chrome	33.7	4.53	6.90	5.62	xtra-hazardou	extra-hazardous	extra-hazardous	0.27	0.41	0.34
Mercury	0.024	0.01	0.01	0.01	permissible	permissible	permissible	0.07	0.10	0.08
Zc metals	25.36						moderately hazardous			

Note: * - values exceed the intervention level (IL)

In terms of the average content of volatile aromatic hydrocarbons and metals, site's 8 soil belong to the **permissible** contamination class; in terms of the average content of **benz(a)pyrene** – to the **hazardous** contamination class.

The values of the total soil pollution index Zc calculated for a series of metals was equal to 25.36 to correspond to the **moderately hazardous** soil contamination class of site's 8 soils.

At the same time, at the site, the MPC for chrome and Kmax values (according to Methodological Guidelines 2.1.7.730-99) were exceeded to correspond to the **extra-hazardous** soil contamination class.

In general, the level of soil contamination at the surveyed area of the drum storage facility on the coast can be assessed as **extra-hazardous.**

Assessment according to international standards

Permissible concentrations (PC) of oil products, copper and nickel were exceeded in the site's soils at separate points, including:

- oil products - up to 106.0 PC units;
- copper - up to 3.46 PC units;
- nickel - up to 1.81 PC units.

In general, the average content of pollutants for the site exceeds the PC values as follows: oil products – 83.8 times; copper – 2.4 times and nickel – 1.4 times

It is necessary to pay special attention to the fact that the level of soil contamination with oil products at the site **exceeds the intervention level** in the values at separate points of testing (up to 1.1 IL).

5.3.2.4 Comparative analysis of the level of contamination of the sites on Hoffman Island

A comparative analysis of soil contamination at the surveyed sites allows us to make the following conclusion:

- In terms of the content of **petroleum hydrocarbons**, the most contaminated soils are located in the settlement (site 6), for which the average concentration of petroleum hydrocarbons **3.4 times** exceeds the **intervention level** according to international standards
- Site's 6 soils are the most contaminated with **polycyclic aromatic hydrocarbon** compounds. The average concentration of PAHs (in total) **2.3 times** exceeds the PC international standards, while in terms of the content of **benz(a)pyrene** the site's soils belong to the **extra-hazardous contamination class** according to SanPiN 2.1.7.1287-03.
- The highest levels of the content of **polychlorinated biphenyls** were detected in soils in the vicinity of the drum storage facility on the glacier (site 7). At the same time, none of the surveyed sites had the average concentration of PCBs in soils reaching **MPC** and **PC** to correspond to the **permissible** contamination class according to SanPiN 2.1.7.1287-03;
- The contamination of soils at all the surveyed sites with a series of heavy metals (according to Zc index) corresponded to the **moderate hazardous contamination class** according to SanPiN 2.1.7.1287-03;

In general, the level of soil contamination at the surveyed sites can be assessed as follows:

- **extra-hazardous** for the settlement area (site 6);
- **extra-hazardous** for the drum storage facility on the glacier area (site 7);
- **extra-hazardous** for the drum storage facility on the coast area (site 8).

Figure 5.3-22 shows the comparative analysis of the average content of pollutants in soils of the surveyed areas on Hoffman Island

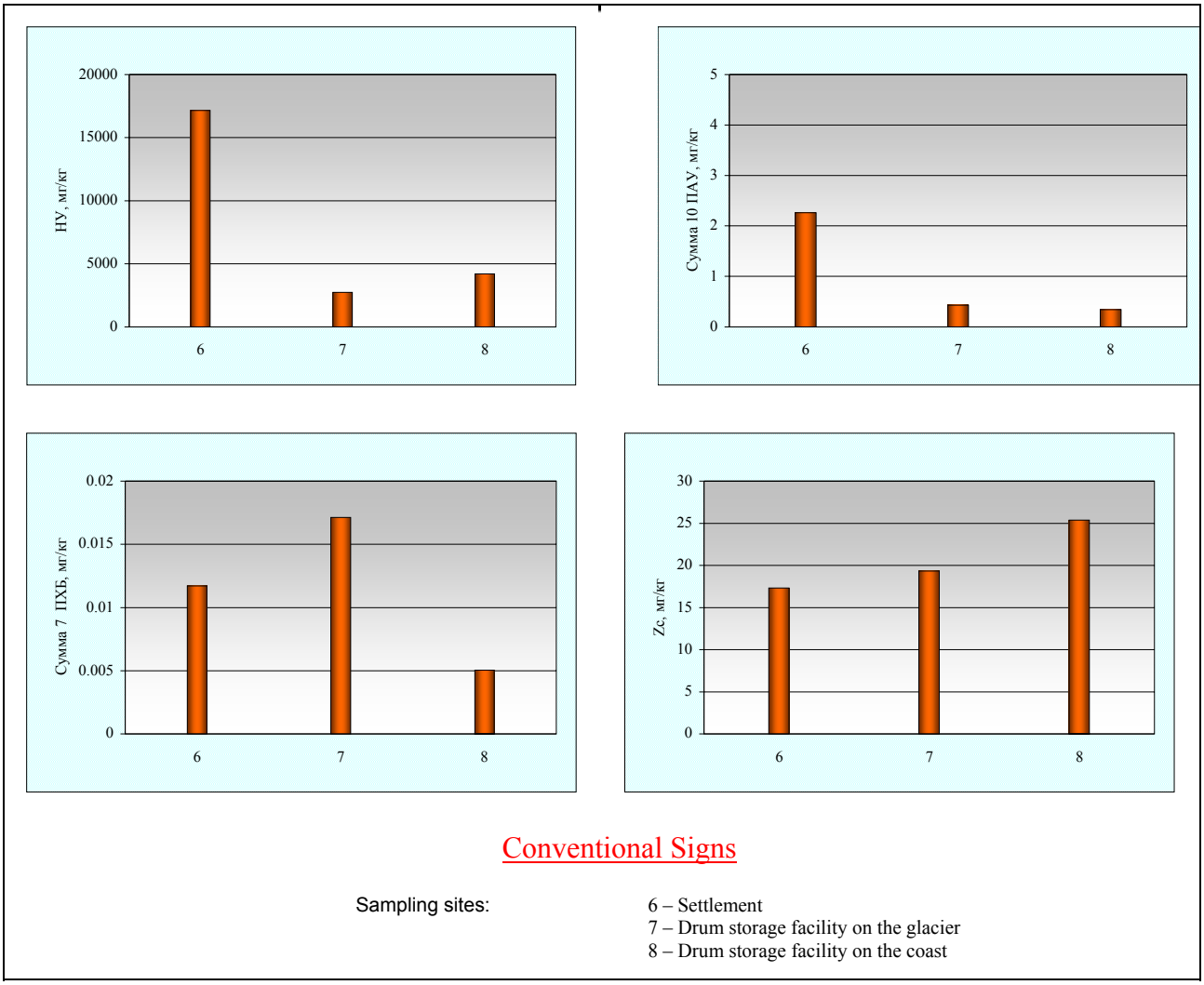


Figure5.3-22 Average values of the total pollution index Zc and average values petroleum hydrocarbons, PAH and PCB concentrations at the surveyed sites on Hoffman Island

5.3.3 Graham Bell Island

5.3.3.1 Aviation camp and landing strip (sites 2 and 3)

100 soil samples at 20 points of geoecological testing were collected **at site 2 on Graham Bell Island (aviation camp)** to assess the contamination level

Assessment according to Russian standards

The content of VAH compounds in soils at the site amounted to:

- benzene - 0.004 mg/kg (up to 0.01 MPC units);
- toluene - 0.093 mg/kg (up to 0.31 MPC units);
- ∑ meta- and para-xylene - 0.076 mg/kg (up to 0.25 MPC units);
- ortho-xylene - 0.052 (up to 0.17 MPC units);
- isopropylbenzene - 0.062 mg/kg (up to 0.12 MPC units).

The content of benz(a)pyrene amounted to 5.605 mg/kg (up to 280.3 MPC units, point S02-024). The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents.

The content of heavy metals reached:

- manganese - 116.0 mg/kg (up to 0.08 MPC units, point S02-020);
- zinc - 93.4 mg/kg (up to 1.70 APC units, point S02-019);
- copper - 9.9 mg/kg (up to 0.30 APC units, point S02-020);
- nickel - 13.4 mg/kg (up to 0.67 APC units, point S02-016);
- lead - 61.6 mg/kg (up to 1.93 MPC units, point S02-020);
- chrome (mobile form) – 6.8 mg/kg (up to 1.13 MPC units, point S02-018);
- cadmium - 0.60 mg/kg (up to 1.20 APC units, point S02-031);
- mercury - 0.03 mg/kg (up to 0.01 MPC units, point S02-020).

The total PCB content reached up to 0.219 mg/kg (up to 4 APC units, point S02-015).

Intervals of pollutant content in soils at site's 2 points of geoecological testing in mass concentration values and MPC, APC and PC units are given in Table 5.3-18 at the end of the Section

Table 5.3-17 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards.

Table 5.3-17 Assessment of the levels of soil contamination at the aviation camp area (site 2) according to SanPiN 2.1.7.1287-03 and international standards

Index	Site 2									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	9590							1.06	**4050***	**191.8***
Benzene	<0.001	0.00	0.01	0.00	permissible	permissible	permissible	0.00	0.09	0.01
Toluene	0.008	0.00	0.31	0.03	permissible	permissible	permissible	0.00	0.19	0.02
Ethylbenzene	0.011							0.00	1.37	0.21
∑ meta- and para-Xylene	0.024	0.00	0.25	0.08	permissible	permissible	permissible	0.00	0.15	0.05
Ortho-Xylene	0.011	0.00	0.17	0.04	permissible	permissible	permissible	0.00	0.10	0.02
Isopropylbenzene	0.009	0.00	0.12	0.02	permissible	permissible	permissible			
Benz(a)pyrene	0.2291	0.00	280.26	11.45	permissible	extra-hazardous	extra-hazardous			
Total 10 PAHs	4.6797							0.07	**100.44***	4.68
Total 7 PCBs	0.017	0.01	3.65	0.28	permissible	hazardous	permissible	0.02	10.96	0.83
Manganese	51.3	0.01	0.08	0.03	permissible	permissible	permissible			
Zinc	18.0	0.07	1.70	0.33	permissible	extra-hazardous	permissible	0.03	0.67	0.13
Copper	3.1	0.02	0.30	0.09	permissible	permissible	permissible	0.02	0.28	0.09
Nickel	3.9	0.04	0.67	0.20	permissible	permissible	permissible	0.02	0.38	0.11
Cobalt	1.0							0.02	0.16	0.05
Lead	10.0	0.03	1.93	0.31	permissible	extra-hazardous	permissible	0.01	0.72	0.12
Cadmium	0.13	0.02	1.20	0.25	permissible	extra-hazardous	permissible	0.01	0.75	0.16
Chrome	2.4	0.07	1.13	0.41	permissible	hazardous	permissible	0.00	0.07	0.02
Mercury	0.009	0.00	0.01	0.00	permissible	permissible	permissible	0.00	0.10	0.03
Zc metals	-2.82						permissible			

Note: * - values exceed the intervention level (IL)

In terms of the average content of volatile aromatic hydrocarbons, the total PCB, manganese, zinc, copper, nickel, lead, cadmium, chrome and mercury, site's 2 soil belongs to the **permissible** contamination class; in terms of the average content of **benz(a)pyrene** – to the **extra-hazardous** contamination class.

The values of the total soil pollution index Zc calculated for a series of metals varied from 6.12 to 3.82 (the average value was 2.8), to correspond tothe **permissible** oil contamination class.

At the same time, at testing points (S02-018 and S02-020) in part of samples, the MPC or APC for zinc, lead and cadmium and Kmax values (according to Methodological Guidelines 2.1.7.730-99) were exceeded to correspond to the **extra-hazardous** soil contamination class.

In general, the level of soil contamination at the surveyed area of the aviation camp can be assessed as **extra-hazardous**

Assessment according to international standards

Permissible concentrations (PC) of oil products, ethylbenzene, total PAHs and total PCBs were exceeded in the site's soils at separate points, including:

- oil products - up to 4050 PC units;
- ethylbenzene - up to 1.4 PC units;
- total PAHs – up to 100 PC units;
- total PCBs – up to 11 PC units.

In general, the average content of pollutants for the site exceeds the PC values as follows: oil products – 192 times; total PAHs – 192 times.

It is necessary to pay special attention to the fact that the level of soil contamination with **PAH and oil products** at the site **exceeds the intervention level.** Total PAH reached up to 2.5 IL; oil products – both in the average value (1.9 times) and in the values at separate points of geoecological testing (up to 40 IL)

Figures 5.3-23 - 5.3-26 show spatial characteristics of the level of site's 2 soil contamination with oil products, total PAHs, total PCBs in PC units and integrated pollution with heavy metals in Zc units

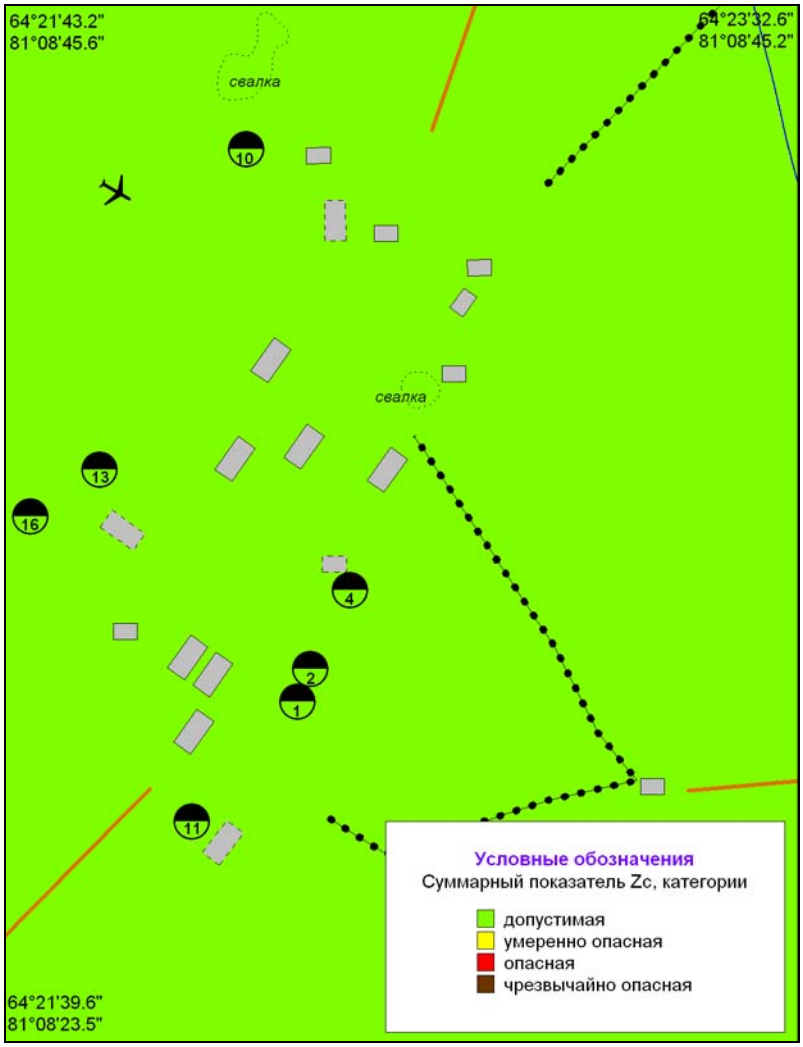


Figure 5.3-23 Spatial characteristics of the level of soil contamination of the aviation camp area (site 2) with a series of heavy metals (Zc)

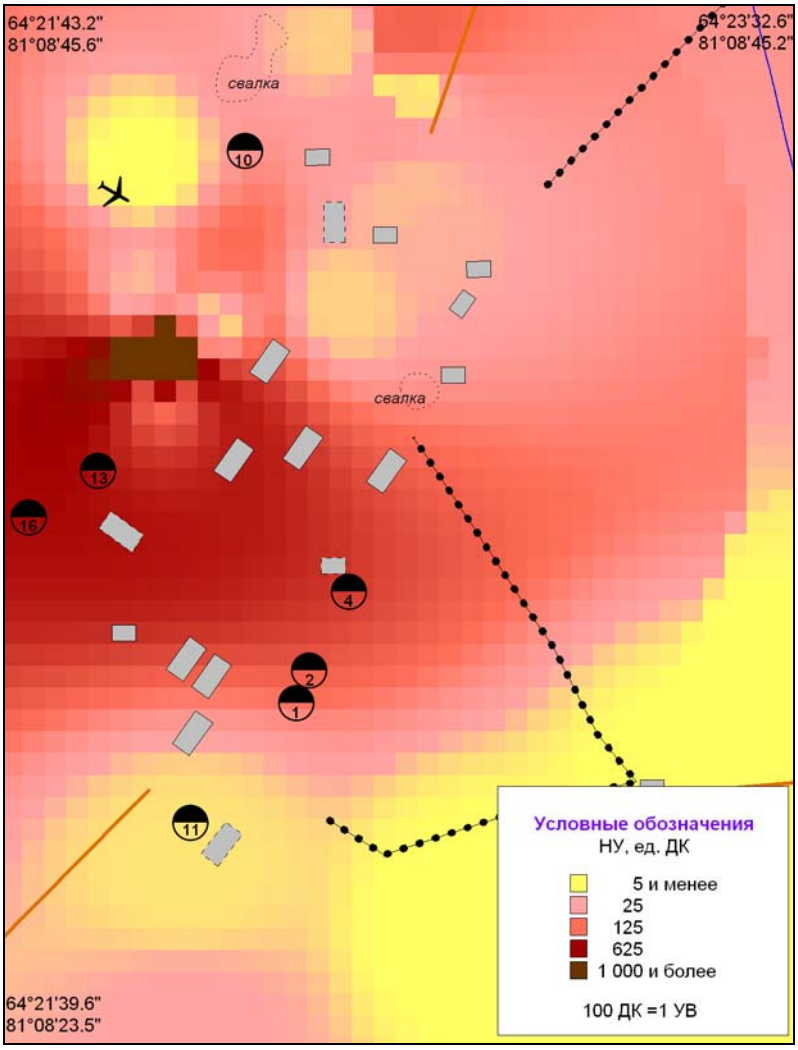
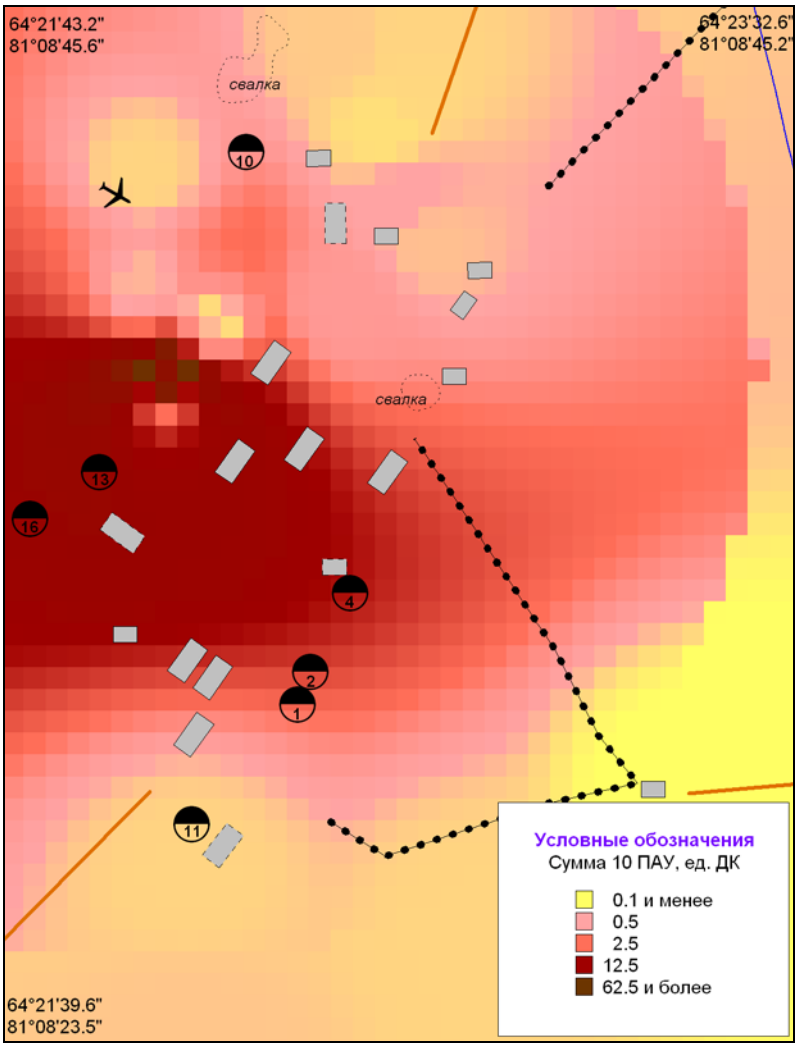
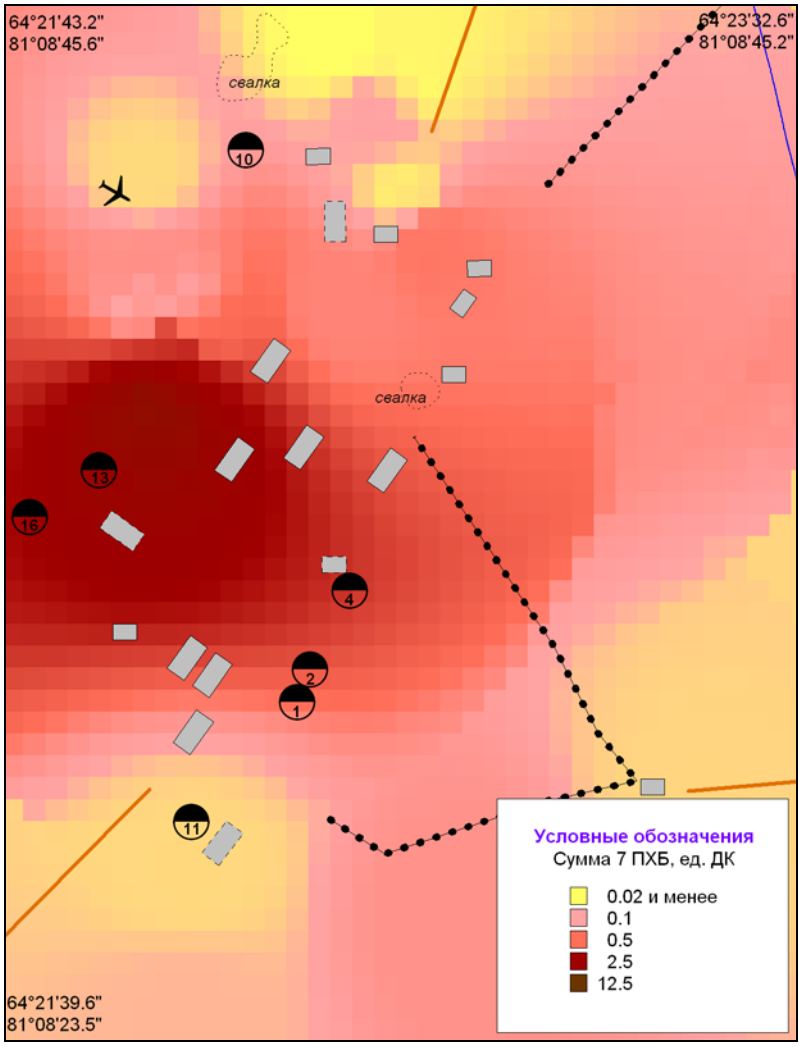


Figure 5.3-24 Spatial characteristics of the level of soil contamination of the aviation camp area (site 2) with petroleum hydrocarbons (oil products)



Note: Total 10 PAHs - anthracene, benz(a)anthracene, benz(k)fluoranthene, benz(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(123cd)pyrene, naphthalene, benz(ghi)perylene

Figure 5.3-25 Spatial characteristics of the level of soil contamination of the aviation camp area (site 2) with polycyclic aromatic hydrocarbons



Note: Total 7 PCBs - # 28, # 52, # 101, # 118, # 138, # 153, # 180

Figure 5.3-26 Spatial characteristics of the level of soil contamination of the aviation camp area (site 2) with polychlorinated biphenyls

Table 5.3-18 Content of pollutants in the intervals of mass concentration and MPC, APC and PC units in soils at site's 2 points

Index	Point number											
	S02-015						S02-016					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	6456	17000	11593	129.12*	340.00*	231.86*	407	1067	645	8.14*	21.34*	12.91*
Benzene	0.003	0.004	0.004	0.01	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Toluene	0.077	0.093	0.085	0.26	0.31	0.28	0.016	0.021	0.018	0.05	0.07	0.06
Ethylbenzene	0.023	0.033	0.028	0.46*	0.65*	0.55*	0.005	0.013	0.010	0.09*	0.26*	0.21*
∑ meta- and para-Xylene	0.053	0.076	0.064	0.18	0.25	0.21	0.033	0.060	0.046	0.11	0.20	0.15
Ortho-Xylene	0.004	0.006	0.005	0.01	0.02	0.02	0.004	0.006	0.005	0.01	0.02	0.02
Isopropylbenzene	0.009	0.021	0.015	0.02	0.04	0.03	0.016	0.019	0.017	0.03	0.04	0.03
Benz(a)pyrene	0.0061	0.0083	0.0074	0.31	0.42	0.37	0.0110	0.0218	0.0168	0.55	1.09	0.84
Total 10 PAHs	0.1501	0.2410	0.2071	0.15*	0.24*	0.21*	0.2845	0.4181	0.3656	0.28*	0.42*	0.37*
Total 7 PCBs	0.197	0.219	0.207	3.29	3.65	3.46	0.001	0.001	0.001	0.02	0.02	0.02
Manganese	25	54.0	39.5	0.02	0.04	0.03	34.6	68.8	52.5	0.02	0.05	0.03
Zinc	4.3	9.4	7.4	0.08	0.17	0.13	5.2	7.5	6.3	0.09	0.14	0.12
Copper	3.1	6.7	4.9	0.09	0.20	0.15	1.8	3	2.3	0.05	0.09	0.07
Nickel	4.6	9.7	7.1	0.23	0.49	0.36	5.5	13.4	9.4	0.28	0.67	0.47
Cobalt	0.8	1.1	0.9	0.04*	0.06*	0.05*	2.2	3.2	2.7	0.11*	0.16*	0.14*
Lead	7.8	11.6	9.8	0.24	0.36	0.31	5.3	8.6	7.1	0.17	0.27	0.22
Cadmium	0.09	0.13	0.11	0.19	0.25	0.21	0.11	0.26	0.19	0.21	0.51	0.38
Chrome	1.7	2.8	2.2	0.28	0.47	0.36	1.9	3.1	2.6	0.32	0.52	0.44
Mercury	0.020	0.027	0.023	0.01	0.01	0.01	0.010	0.013	0.012	0.00	0.01	0.01

Index	Point number											
	S02-017						S02-018					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	402	1794	1017	8.04*	35.88*	20.34*	63	452	264	1.26*	9.04*	5.28*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.016	0.022	0.019	0.05	0.07	0.06	0.008	0.010	0.009	0.03	0.03	0.03
Ethylbenzene	0.050	0.069	0.058	0.99*	1.37*	1.16*	0.026	0.047	0.039	0.52*	0.94*	0.79*
∑ meta- and para-Xylene	0.050	0.066	0.057	0.17	0.22	0.19	0.033	0.044	0.037	0.11	0.15	0.12
Ortho-Xylene	0.031	0.038	0.034	0.10	0.13	0.11	0.020	0.027	0.024	0.07	0.09	0.08
Isopropylbenzene	0.052	0.062	0.058	0.10	0.12	0.12	0.045	0.061	0.052	0.09	0.12	0.10
Benz(a)pyrene	0.0277	0.0440	0.0349	1.39	2.20	1.75	0.0069	0.0102	0.0083	0.35	0.51	0.42
Total 10 PAHs	0.3704	0.4612	0.4005	0.37*	0.46*	0.40*	0.1086	0.1351	0.1228	0.11*	0.14*	0.12*
Total 7 PCBs	0.005	0.005	0.005	0.08	0.09	0.09	0.002	0.003	0.002	0.04	0.04	0.04
Manganese	19.8	28.0	23.6	0.01	0.02	0.02	45.7	92.2	70.7	0.03	0.06	0.05
Zinc	5.3	9.6	7.7	0.10	0.17	0.14	5.4	10.2	8.6	0.10	0.19	0.16
Copper	1.5	3.4	2.6	0.05	0.10	0.08	5.1	9.1	6.9	0.15	0.28	0.21
Nickel	4.8	10.4	7.7	0.24	0.52	0.38	1.8	3.2	2.7	0.09	0.16	0.13
Cobalt	1.3	1.9	1.6	0.07*	0.10*	0.08*	0.8	1.0	0.9	0.04*	0.05*	0.05*
Lead	3.2	5.3	4.5	0.10	0.17	0.14	26.7	51.6	41.6	0.83	1.61	1.30
Cadmium	0.16	0.28	0.23	0.32	0.55	0.46	0.07	0.13	0.11	0.14	0.27	0.21
Chrome	1.5	3.3	2.6	0.25	0.55	0.43	4.1	6.8	5.5	0.68	1.13	0.91
Mercury	0.010	0.014	0.012	0.00	0.01	0.01	0.007	0.008	0.007	0.00	0.00	0.00

Continuation of Table 5.3-18

Index	Point number											
	S02-019						S02-020					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	235	480	352	4.70*	9.60*	7.04*	503	1014	755	10.06*	20.28*	15.10*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.003	0.004	0.004	0.01	0.01	0.01	0.003	0.004	0.003	0.01	0.01	0.01
Ethylbenzene	0.022	0.042	0.033	0.43*	0.83*	0.66*	0.014	0.026	0.021	0.29*	0.52*	0.43*
∑ meta- and para-Xylene	0.038	0.070	0.056	0.13	0.23	0.19	0.021	0.039	0.032	0.07	0.13	0.11
Ortho-Xylene	0.015	0.020	0.018	0.05	0.07	0.06	0.014	0.016	0.015	0.05	0.05	0.05
Isopropylbenzene	0.002	0.002	0.002	0.00	0.00	0.00	0.022	0.029	0.026	0.04	0.06	0.05
Benz(a)pyrene	0.0050	0.0062	0.0053	0.25	0.31	0.27	0.1097	0.1923	0.1521	5.49	9.62	7.61
Total 10 PAHs	0.0875	0.1074	0.0976	0.09*	0.11*	0.10*	0.8210	0.9720	0.8957	0.82*	0.97*	0.90*
Total 7 PCBs	0.010	0.012	0.011	0.17	0.20	0.19	0.006	0.008	0.007	0.10	0.13	0.11
Manganese	50.0	74.3	60.7	0.03	0.05	0.04	83.6	116.0	99.1	0.06	0.08	0.07
Zinc	71.3	93.4	84.8	1.30	1.70	1.54	43.7	60.2	52.5	0.79	1.09	0.95
Copper	3.9	7.6	5.1	0.12	0.23	0.16	4.1	9.9	6.5	0.12	0.30	0.20
Nickel	3.1	6.7	4.7	0.16	0.34	0.23	2.6	3.8	3.2	0.13	0.19	0.16
Cobalt	0.6	1.3	0.8	0.03*	0.07*	0.04*	0.7	1.6	1.0	0.04*	0.08*	0.05*
Lead	7.3	16.4	11.8	0.23	0.51	0.37	44.3	61.6	51.7	1.38	1.93	1.62
Cadmium	0.09	0.20	0.14	0.18	0.40	0.28	0.06	0.20	0.10	0.12	0.40	0.20
Chrome	3.0	6.2	4.6	0.50	1.03	0.76	1.2	2.7	2.0	0.20	0.45	0.33
Mercury	0.003	0.010	0.007	0.00	0.00	0.00	0.008	0.030	0.016	0.00	0.01	0.01

Index	Point number											
	S02-021						S02-022					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	732	1600	1116	14.64*	32.00*	22.33*	528	1300	992	10.56*	26.00*	19.84*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ethylbenzene	0.003	0.006	0.005	0.06*	0.12*	0.10*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.017	0.023	0.020	0.06	0.08	0.07	0.016	0.031	0.025	0.05	0.10	0.08
Ortho-Xylene	0.010	0.012	0.011	0.03	0.04	0.04	0.019	0.025	0.022	0.06	0.08	0.07
Isopropylbenzene	0.001	0.002	0.002	0.00	0.00	0.00	0.002	0.002	0.002	0.00	0.00	0.00
Benz(a)pyrene	<0.0005	<0.0005	<0.0005	0.00	0.00	0.00	0.0076	0.0164	0.0117	0.38	0.82	0.59
Total 10 PAHs	0.3470	0.4235	0.3783	0.35*	0.42*	0.38*	0.4360	0.6041	0.5258	0.44*	0.60*	0.53*
Total 7 PCBs	0.008	0.010	0.009	0.13	0.16	0.15	0.001	0.001	0.001	0.01	0.01	0.01
Manganese	34.6	53.4	45.2	0.02	0.04	0.03	43.1	63.8	53.9	0.03	0.04	0.04
Zinc	17.4	28.3	22.7	0.32	0.51	0.41	8.5	13.2	10.6	0.15	0.24	0.19
Copper	2.5	4.7	3.7	0.08	0.14	0.11	1.8	3.1	2.4	0.05	0.09	0.07
Nickel	3.6	4.3	4.0	0.18	0.22	0.20	3.2	5.2	4.1	0.16	0.26	0.21
Cobalt	0.6	1.3	1.0	0.03*	0.07*	0.05*	0.7	1.3	1.0	0.04*	0.07*	0.05*
Lead	10.5	21.3	15.8	0.33	0.67	0.49	2.4	5.3	3.4	0.08	0.17	0.11
Cadmium	0.05	0.12	0.08	0.10	0.24	0.16	0.05	0.07	0.06	0.10	0.14	0.12
Chrome	2.3	5.4	3.3	0.38	0.90	0.56	1.9	2.7	2.4	0.32	0.45	0.40
Mercury	0.006	0.020	0.011	0.00	0.01	0.01	0.005	0.010	0.007	0.00	0.00	0.00

Continuation of Table 5.3-18

Index	Point number											
	S02-023						S02-024					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	664	1150	896	13.28*	23.00*	17.92*	19720	72500	50552	394.40*	1450.00*	1011.04*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	0.002	0.003	0.003	0.01	0.01	0.01	0.009	0.016	0.012	0.03	0.05	0.04
Ethylbenzene	<0.001	0.001	<0.001	0.00*	0.02*	0.00*	0.013	0.016	0.015	0.25*	0.33*	0.29*
∑ meta- and para-Xylene	0.045	0.071	0.060	0.15	0.24	0.20	0.049	0.065	0.058	0.16	0.22	0.19
Ortho-Xylene	0.037	0.052	0.045	0.12	0.17	0.15	0.032	0.040	0.037	0.11	0.13	0.12
Isopropylbenzene	0.003	0.004	0.004	0.01	0.01	0.01	0.003	0.006	0.004	0.01	0.01	0.01
Benz(a)pyrene	0.0134	0.0215	0.0177	0.67	1.08	0.89	2.9041	5.6051	4.0718	145.21	280.26	203.59
Total 10 PAHs	0.1790	0.2301	0.2088	0.18*	0.23*	0.21*	61.9802	100.442	78.449	61.98*0	100.44*	78.45*
Total 7 PCBs	0.001	0.001	0.001	0.01	0.01	0.01	0.037	0.051	0.043	0.62	0.85	0.72
Manganese	36.4	50.4	45.1	0.02	0.03	0.03	43.5	54.0	48.5	0.03	0.04	0.03
Zinc	9.2	15.3	12.1	0.17	0.28	0.22	14.7	20.7	17.2	0.27	0.38	0.31
Copper	1.2	2.2	1.7	0.04	0.07	0.05	3.0	4.1	3.5	0.09	0.12	0.11
Nickel	3.3	4.2	3.7	0.17	0.21	0.19	2.1	3.3	2.8	0.11	0.17	0.14
Cobalt	0.5	1.2	0.9	0.03*	0.06*	0.04*	0.8	1.3	1.1	0.04*	0.07*	0.05*
Lead	1.0	1.6	1.3	0.03	0.05	0.04	7.6	13.5	9.4	0.24	0.42	0.30
Cadmium	0.04	0.08	0.06	0.08	0.16	0.11	0.02	0.08	0.05	0.04	0.16	0.10
Chrome	1.5	2.2	1.9	0.25	0.37	0.31	2.7	3.8	3.3	0.45	0.63	0.55
Mercury	<0.003	0.009	0.003	0.00	0.00	0.00	0.008	0.011	0.010	0.00	0.01	0.00

Index	Point number											
	S02-025						S02-026					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	52460	202500	109242	1049.20*	4050.00*	2184.84*	834	2674	1947	16.68*	53.48*	38.94*
Benzene	0.001	0.001	0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	0.002	0.002	0.002	0.01	0.01	0.01	0.001	0.004	0.002	0.00	0.01	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.02*	0.02*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.003	0.002	0.01	0.01	0.01
Ortho-Xylene	0.001	0.001	0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	0.001	0.001	0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.1260	0.2156	0.1681	6.30	10.78	8.40	<0.0005	<0.0005	<0.0005	0.00	0.00	0.00
Total 10 PAHs	8.2772	10.6460	9.5379	8.28*	10.65*	9.54*	0.2089	0.2654	0.2313	0.21*	0.27*	0.23*
Total 7 PCBs	0.027	0.034	0.030	0.45	0.56	0.51	0.002	0.003	0.002	0.04	0.04	0.04
Manganese	16.0	29.6	22.6	0.01	0.02	0.02	15.8	35.0	26.7	0.01	0.02	0.02
Zinc	15.5	24.1	19.9	0.28	0.44	0.36	6.1	14.4	9.7	0.11	0.26	0.18
Copper	1.5	2.3	2.1	0.05	0.07	0.06	1.2	3.5	2.4	0.04	0.11	0.07
Nickel	3.2	5.1	4.2	0.16	0.26	0.21	1.4	1.9	1.6	0.07	0.10	0.08
Cobalt	0.4	0.5	0.4	0.02*	0.03*	0.02*	0.6	0.8	0.7	0.03*	0.04*	0.03*
Lead	3.9	5.8	5.0	0.12	0.18	0.16	1.4	2.5	2.0	0.04	0.08	0.06
Cadmium	0.08	0.12	0.10	0.15	0.24	0.19	0.05	0.08	0.07	0.11	0.16	0.14
Chrome	0.6	1.4	1.1	0.10	0.23	0.18	0.4	0.8	0.6	0.07	0.13	0.10
Mercury	0.002	0.003	0.002	0.00	0.00	0.00	0.003	0.004	0.003	0.00	0.00	0.00

Continuation of Table 5.3-18

Index	Point number											
	S02-027						S02-028					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	210	399	298	4.20*	7.98*	5.97*	5216	12515	9000	104.32*	250.30*	180.00*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.003	0.002	0.01	0.01	0.01
Ethylbenzene	<0.001	0.002	0.001	0.00*	0.03*	0.02*	<0.001	0.002	<0.001	0.00*	0.03*	0.02*
∑ meta- and para-Xylene	<0.001	0.002	0.001	0.00	0.01	0.00	0.001	0.002	0.002	0.00	0.01	0.01
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0132	0.0182	0.0161	0.66	0.91	0.81	0.0045	0.0077	0.0058	0.23	0.39	0.29
Total 10 PAHs	0.2261	0.3049	0.2719	0.23*	0.30*	0.27*	0.2176	0.3358	0.2856	0.22*	0.34*	0.29*
Total 7 PCBs	0.000	0.001	0.000	0.01	0.01	0.01	0.001	0.001	0.001	0.01	0.01	0.01
Manganese	37.2	52.1	41.5	0.02	0.03	0.03	28.4	62.6	45.6	0.02	0.04	0.03
Zinc	11.2	13.7	12.7	0.20	0.25	0.23	3.7	5.2	4.7	0.07	0.09	0.09
Copper	2.0	3.1	2.5	0.06	0.09	0.08	1.6	2.3	1.9	0.05	0.07	0.06
Nickel	4.2	5.3	4.8	0.21	0.27	0.24	1.6	4.2	2.9	0.08	0.21	0.15
Cobalt	0.5	0.9	0.6	0.03*	0.05*	0.03*	0.4	0.5	0.5	0.02*	0.03*	0.02*
Lead	2.4	3.1	2.7	0.08	0.10	0.09	1.3	2.3	1.8	0.04	0.07	0.06
Cadmium	0.01	0.04	0.03	0.02	0.08	0.05	0.04	0.07	0.05	0.08	0.13	0.11
Chrome	2.2	3.2	2.7	0.37	0.53	0.46	1.6	2.5	2.2	0.27	0.42	0.36
Mercury	<0.003	0.009	0.003	0.00	0.00	0.00	0.006	0.007	0.007	0.00	0.00	0.00

Index	Point number											
	S02-029						S02-030					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	432	1058	747	8.64*	21.16*	14.94*	53	295	154	1.06*	5.90*	3.08*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.001	0.002	0.002	0.00	0.01	0.00
Ethylbenzene	<0.001	0.002	0.001	0.00*	0.04*	0.03*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.001	0.002	0.001	0.00	0.01	0.00	0.001	0.002	0.002	0.00	0.01	0.01
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	0.001	0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0045	0.0064	0.0052	0.23	0.32	0.26	0.0198	0.0322	0.0266	0.99	1.61	1.33
Total 10 PAHs	0.2812	0.3783	0.3306	0.28*	0.38*	0.33*	0.2638	0.2991	0.2838	0.26*	0.30*	0.28*
Total 7 PCBs	0.000	0.000	0.000	0.01	0.01	0.01	0.001	0.001	0.001	0.02	0.02	0.02
Manganese	34.8	40.3	37.6	0.02	0.03	0.03	60.4	100.6	79.7	0.04	0.07	0.05
Zinc	5.4	6.3	5.9	0.10	0.11	0.11	9.8	25.3	17.8	0.18	0.46	0.32
Copper	1.1	1.8	1.5	0.03	0.05	0.04	1.9	4.4	3.4	0.06	0.13	0.10
Nickel	2.4	3.2	2.8	0.12	0.16	0.14	1.6	3.8	2.8	0.08	0.19	0.14
Cobalt	0.4	0.7	0.6	0.02*	0.04*	0.03*	0.5	0.7	0.6	0.03*	0.04*	0.03*
Lead	1.2	2.6	2.0	0.04	0.08	0.06	6.3	9.5	7.7	0.20	0.30	0.24
Cadmium	0.01	0.02	0.01	0.02	0.04	0.03	0.08	0.12	0.10	0.16	0.25	0.21
Chrome	1.1	1.7	1.5	0.18	0.28	0.24	0.8	1.9	1.5	0.13	0.32	0.25
Mercury	<0.003	0.005	<0.003	0.00	0.00	0.00	0.003	0.004	0.004	0.00	0.00	0.00

Continuation of Table 5.3-18

Index	Point number											
	S02-031						S02-032					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	701	1825	1260	14.02*	36.50*	25.20*	318	762	544	6.36*	15.24*	10.88*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.001	0.002	0.001	0.00	0.01	0.00
Ethylbenzene	<0.001	0.001	<0.001	0.00*	0.02*	0.02*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.001	0.002	0.001	0.00	0.01	0.00
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0098	0.0158	0.0127	0.49	0.79	0.63	0.0017	0.0027	0.0022	0.09	0.14	0.11
Total 10 PAHs	0.2803	0.3814	0.3484	0.28*	0.38*	0.35*	0.2525	0.3070	0.2883	0.25*	0.31*	0.29*
Total 7 PCBs	0.002	0.002	0.002	0.03	0.03	0.03	0.001	0.001	0.001	0.02	0.02	0.02
Manganese	49.1	62.3	56.6	0.03	0.04	0.04	41.3	76.1	60.8	0.03	0.05	0.04
Zinc	7.1	12.5	9.5	0.13	0.23	0.17	10.9	20.8	15.2	0.20	0.38	0.28
Copper	1.6	3.2	2.2	0.05	0.10	0.07	1.5	3.0	2.4	0.05	0.09	0.07
Nickel	3.5	4.2	3.8	0.18	0.21	0.19	0.9	2.0	1.5	0.05	0.10	0.07
Cobalt	0.5	0.7	0.6	0.03*	0.04*	0.03*	1.5	1.9	1.7	0.08*	0.10*	0.09*
Lead	4.1	5.2	4.5	0.13*	0.16*	0.14*	3.3	7.4	6.4	0.10*	0.23*	0.20*
Cadmium	0.40	0.60	0.48	0.80	1.20	0.96	0.09	0.13	0.11	0.19	0.27	0.23
Chrome	1.0	1.7	1.3	0.17	0.28	0.21	2.8	4.1	3.4	0.47	0.68	0.56
Mercury	<0.003	0.005	0.003	0.00	0.00	0.00	0.010	0.014	0.012	0.00	0.01	0.01

Index	Point number											
	S02-033						S02-034					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	81	314	214	1.62*	6.28*	4.28*	110	308	209	2.20*	6.16*	4.17*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	0.001	0.002	0.002	0.00	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	0.001	<0.001	0.00*	0.02*	0.01*
∑ meta- and para-Xylene	0.003	0.004	0.004	0.01	0.01	0.01	<0.001	0.001	<0.001	0.00	0.00	0.00
Ortho-Xylene	0.002	0.003	0.002	0.01	0.01	0.01	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0106	0.0187	0.0154	0.53	0.94	0.77	0.0023	0.0044	0.0032	0.12	0.22	0.16
Total 10 PAHs	0.2513	0.3142	0.2845	0.25*	0.31*	0.28*	0.0666	0.0876	0.0810	0.07*	0.09*	0.08*
Total 7 PCBs	0.004	0.005	0.005	0.07	0.09	0.08	0.001	0.001	0.001	0.02	0.02	0.02
Manganese	38.2	101.6	70.3	0.03	0.07	0.05	40.7	53.2	46.7	0.03	0.04	0.03
Zinc	12.7	30.4	21.2	0.23	0.55	0.39	11.1	16.4	14.0	0.20	0.30	0.25
Copper	0.8	1.1	1.0	0.02	0.03	0.03	1.9	2.8	2.4	0.06	0.08	0.07
Nickel	0.8	1.5	1.2	0.04	0.08	0.06	3.2	4.6	4.0	0.16	0.23	0.20
Cobalt	1.8	2.3	2.1	0.09*	0.12*	0.11*	0.4	0.6	0.5	0.02*	0.03*	0.02*
Lead	5.0	9.3	7.4	0.16	0.29	0.23	4.2	5.3	4.7	0.13	0.17	0.15
Cadmium	0.19	0.26	0.22	0.38	0.51	0.45	0.10	0.40	0.22	0.20	0.80	0.44
Chrome	2.2	3.4	2.8	0.37	0.57	0.47	1.3	2.1	1.7	0.22	0.35	0.28
Mercury	0.020	0.024	0.022	0.01	0.01	0.01	0.008	0.020	0.012	0.00	0.01	0.01

40 soil samples at 8 points of geoecological testing were collected **at site 3 on Graham Bell Island (landing strip)** to assess the contamination level.

Assessment according to Russian standards

The content of VAH compounds in soils at the site amounted to:

- benzene - 0.003 mg/kg (up to 0.01 MPC units);
- toluene - 0.004 mg/kg (up to 0.01 MPC units);
- ∑ meta- and para-xylene - 0.005 mg/kg (up to 0.20 MPC units);
- ortho-xylene - 0.050 (up to 0.17 MPC units);
- isopropylbenzene - 0.001 mg/kg (up to 0.002 MPC units).

The content of benz(a)pyrene amounted to 0.0292 mg/kg (up to 1.46 MPC units, points S03-035, S03-037).

The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents

The content of heavy metals reached:

- manganese - 76.5 mg/kg (up to 0.05 MPC units, point S03-037);
- zinc from 3.1 to 10.6 mg/kg (up to 0.19 APC units, point S03-039);
- copper - 3.8 mg/kg (up to 0.12 APC units, point S03-040);
- nickel - 4.7 mg/kg (up to 0.24 APC units, point S03-041);
- lead - 8.6 mg/kg (up to 0.27 MPC units, point S03-040);
- chrome (mobile form) - up to 3.6 mg/kg (up to 0.60 MPC units, point S03-037);
- cadmium - 0.06 mg/kg (up to 0.12 MPC units, point S03-037);
- mercury - 0.008 mg/kg (up to 0.004 MPC units, point S03-035).

The total PCB content reached up to 0.004 mg/kg (up to 0.06 APC units, point S03-040).

Intervals of pollutant content in soils at site's 3 points of geoecological testing in mass concentration values and MPC, APC and PC units are given in Table 5.3-20 at the end of the Section.

Table 5.3-19 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards.

Table 5.3-19 Assessment of the levels of soil contamination at the landing strip area (site 3) according to SanPiN 2.1.7.1287-03 and international standards

Index	Site 3									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	227							0.94	14.40	4.53
Benzene	<0.001	0.00	0.01	0.00	permissible	permissible	permissible	0.00	0.06	0.01
Toluene	0.002	0.00	0.01	0.01	permissible	permissible	permissible	0.00	0.01	0.00
Ethylbenzene	<0.001							0.00	0.03	0.00
∑ meta- and para-Xylene	0.001	0.00	0.02	0.00	permissible	permissible	permissible	0.00	0.01	0.00
Ortho-Xylene	0.004	0.00	0.17	0.01	permissible	permissible	permissible	0.00	0.10	0.01
Isopropylbenzene	<0.001	0.00	0.00	0.00	permissible	permissible	permissible			
Benz(a)pyrene	0.0084	0.00	1.46	0.42	permissible	permissible	permissible			
Total 10 PAHs	0.3409							0.01	1.02	0.34
Total 7 PCBs	0.001	0.00	0.06	0.02	permissible	permissible	permissible	0.01	0.19	0.06
Manganese	37.5	0.01	0.05	0.03	permissible	permissible	permissible			
Zinc	5.7	0.06	0.19	0.10	permissible	permissible	permissible	0.02	0.08	0.04
Copper	1.7	0.02	0.12	0.05	permissible	permissible	permissible	0.02	0.11	0.05
Nickel	2.4	0.04	0.24	0.12	permissible	permissible	permissible	0.02	0.13	0.07
Cobalt	0.7							0.01	0.10	0.04
Lead	3.0	0.02	0.27	0.09	permissible	permissible	permissible	0.01	0.10	0.04
Cadmium	0.02	0.01	0.12	0.04	permissible	permissible	permissible	0.01	0.07	0.03
Chrome	1.7	0.10	0.60	0.28	permissible	permissible	permissible	0.01	0.04	0.02
Mercury	<0.003	0.00	0.00	0.00	permissible	permissible	permissible	0.00	0.03	0.00
Zc metals	-5.92						permissible			

Note: * - values exceed the intervention level (IL)

In terms of the average content of all the substances to be analyzed site's 3 soil belongs to the **permissible** contamination class.

The values of the total soil pollution index Zc calculated for a series of metals varied from 6.88 to 5.25, while the average value for the site was 5.9 to correspond to the **permissible** contamination class.

In general, the level of soil contamination at the surveyed area of the radar station can be assessed as **permissible.**

Assessment according to international standards

Permissible concentrations (PC) of oil products in the site's soils were exceeded; at separate points of testing, they reached up to 14.4 PC units; the average content reached up to 4.5 PC units.

The intervention level has not been reached.

Figures 5.3-27 - 5.3-30 show spatial characteristics of the level of site's 3 soil contamination with oil products, total PAHs, total PCBs in PC units and integrated pollution with heavy metals in Zc units

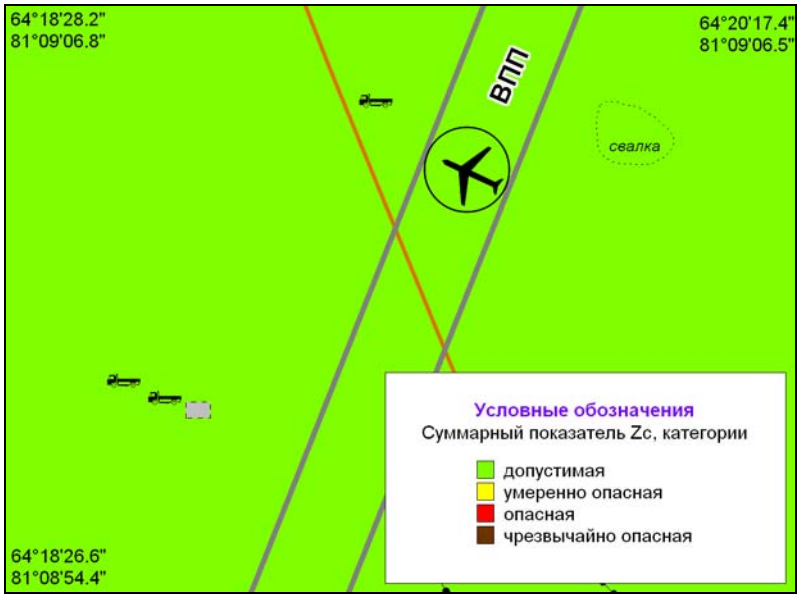


Figure 5.3-27 Spatial characteristics of the level of soil contamination of the landing strip area (site 3) with a series of heavy metals (Zc)

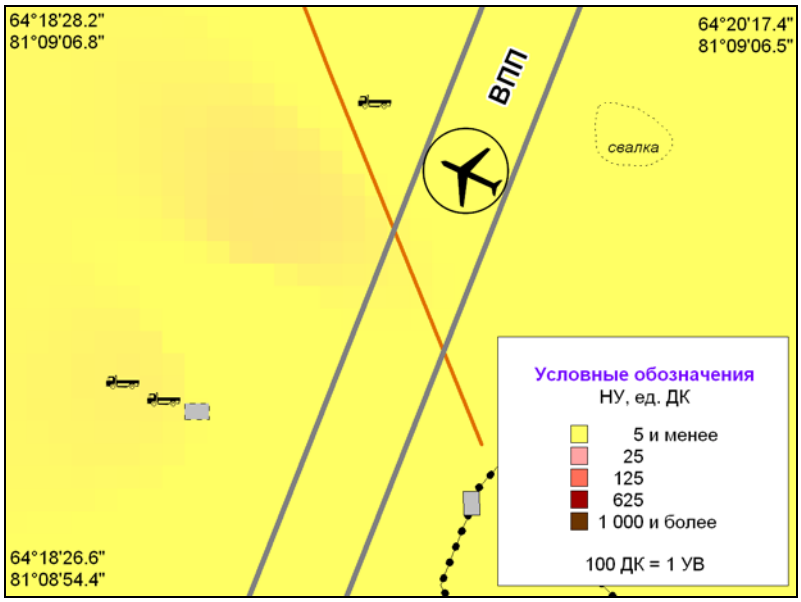
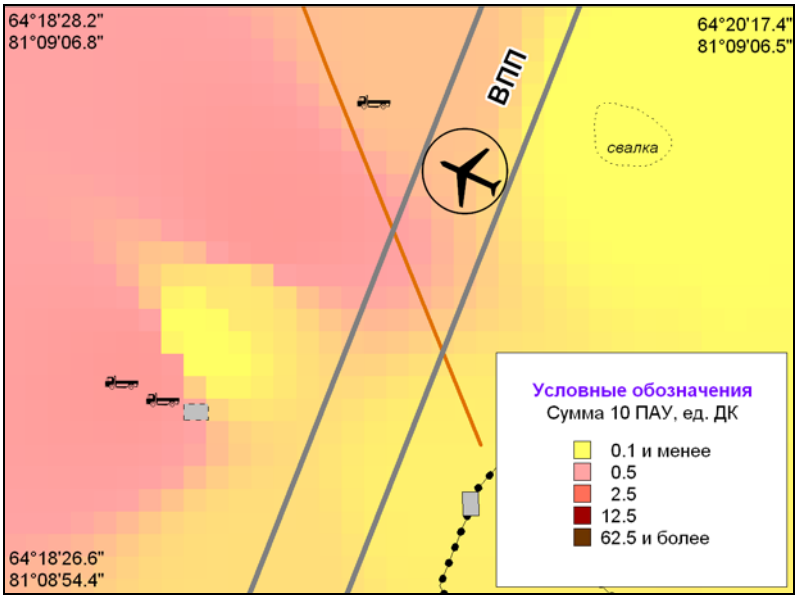
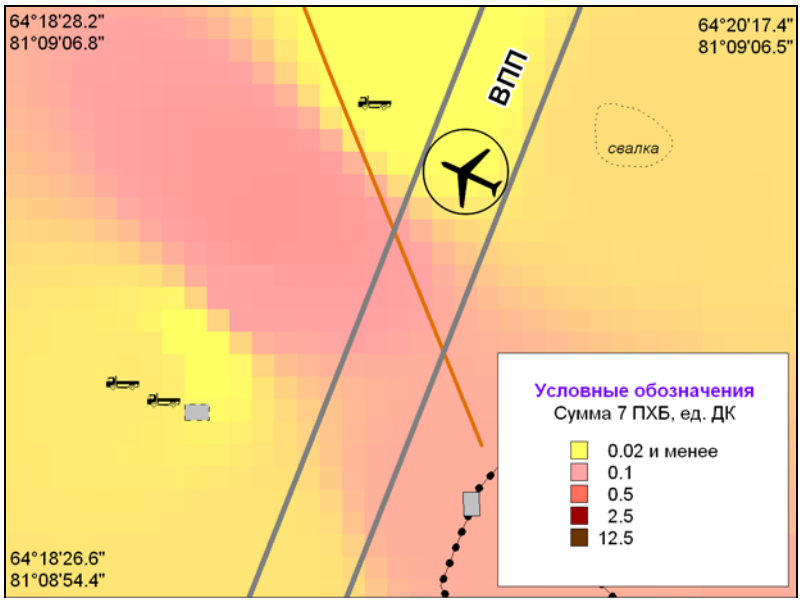


Figure 5.3-28 Spatial characteristics of the level of soil contamination of the landing strip area (site 3) with petroleum hydrocarbons (oil products)



Note: Total 10 PAHs - anthracene, benz(a)anthracene, benz(k)fluoranthene, benz(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(123cd)pyrene, naphthalene, benz(ghi)perylene

Figure 5.3-29… Spatial characteristics of the level of soil contamination of the landing strip area (site 3) with polycyclic aromatic hydrocarbons



Note: Total 7 PCBs - # 28, # 52, # 101, # 118, # 138, # 153, # 180

Figure 5.3-30 Spatial characteristics of the level of soil contamination of the landing strip area (site 3) with polychlorinated biphenyls

Table 5.3-20 Content of pollutants in the intervals of mass concentration and MPC, APC and PC units in soils at site's 3 points

Index	Point number											
	S03-035						S03-037					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	61	196	136	1.22*	3.92*	2.72*	100	672	395	2.00*	13.44*	7.90*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.001	0.003	0.002	0.00	0.01	0.01
Toluene	<0.001	0.001	0.001	0.00	0.00	0.00	0.002	0.003	0.002	0.01	0.01	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.002	0.005	0.003	0.01	0.02	0.01
Ortho-Xylene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0202	0.0292	0.0240	1.01	1.46	1.20	0.0125	0.0247	0.0196	0.63	1.24	0.98
Total 10 PAHs	0.2193	0.2675	0.2437	0.22*	0.27*	0.24*	0.7418	0.9329	0.8250	0.74*	0.93*	0.83*
Total 7 PCBs	0.001	0.001	0.001	0.01	0.02	0.01	0.001	0.001	0.001	0.01	0.01	0.01
Manganese	37.2	51.3	46.4	0.02	0.03	0.03	37.2	76.5	55.8	0.02	0.05	0.04
Zinc	5.3	7.3	6.2	0.10	0.13	0.11	6.4	10.6	8.1	0.12	0.19	0.15
Copper	1.1	2.6	1.8	0.03	0.08	0.05	0.8	1.5	1.1	0.02	0.05	0.03
Nickel	2.4	3.8	3.0	0.12	0.19	0.15	0.8	1.6	1.2	0.04	0.08	0.06
Cobalt	0.5	0.8	0.6	0.03*	0.04*	0.03*	1.3	1.9	1.6	0.07*	0.10*	0.08*
Lead	1.5	2.2	1.8	0.05	0.07	0.06	0.7	1.9	1.5	0.02	0.06	0.05
Cadmium	0.01	0.03	0.02	0.02	0.06	0.04	0.05	0.06	0.05	0.09	0.12	0.10
Chrome	1.3	2.1	1.7	0.22	0.35	0.29	1.5	3.6	2.8	0.25	0.60	0.46
Mercury	<0.003	0.008	0.003	0.00	0.00	0.00	0.003	0.004	0.004	0.00	0.00	0.00

Index	Point number											
	S03-038						S03-039					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	54	162	91	1.08*	3.24*	1.82*	74	282	171	1.48*	5.64*	3.41*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.002	0.003	0.002	0.01	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Ethylbenzene	<0.001	0.001	<0.001	0.00*	0.02*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.001	0.002	0.002	0.00	0.01	0.01	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ortho-Xylene	0.004	0.050	0.014	0.01	0.17	0.05	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0016	0.0028	0.0024	0.08	0.14	0.12	0.0089	0.0182	0.0146	0.45	0.91	0.73
Total 10 PAHs	0.0143	0.0182	0.0155	0.01*	0.02*	0.02*	0.1825	0.2219	0.1989	0.18*	0.22*	0.20*
Total 7 PCBs	0.000	0.000	0.000	0.00	0.00	0.00	0.002	0.002	0.002	0.03	0.04	0.04
Manganese	18.1	34.5	27.7	0.01	0.02	0.02	23.9	34.1	27.4	0.02	0.02	0.02
Zinc	5.8	9.1	7.3	0.11	0.17	0.13	3.1	4.7	3.8	0.06	0.09	0.07
Copper	2	2.7	2.5	0.06	0.08	0.07	0.6	1.2	0.9	0.02	0.04	0.03
Nickel	2.6	4	3.2	0.13	0.20	0.16	0.8	1.5	1.1	0.04	0.08	0.06
Cobalt	0.7	0.8	0.7	0.04*	0.04*	0.04*	0.3	0.6	0.5	0.02*	0.03*	0.02*
Lead	2.3	3.5	3.0	0.07	0.11	0.09	1.2	2.4	1.8	0.04	0.08	0.06
Cadmium	0.03	0.05	0.04	0.05	0.10	0.08	0.01	0.02	0.01	0.01	0.04	0.02
Chrome	1.0	2.1	1.7	0.17	0.35	0.29	0.9	1.4	1.1	0.15	0.23	0.18
Mercury	<0.003	0.003	<0.003	0.00	0.00	0.00	<0.003	<0.003	<0.003	0.00	0.00	0.00

Continuation of Table 5.3-20

Index	Point number											
	S03-040						S03-041					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	315	720	500	6.30*	14.40*	10.01*	46.9	130	81	0.94*	2.60*	1.62
Benzene	0.001	0.002	0.002	0.00	0.01	0.01	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	0.002	0.004	0.003	0.01	0.01	0.01	0.002	0.004	0.003	0.01	0.01	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	0.001	<0.001	0.00*	0.02*	0.00*
∑ meta- and para-Xylene	0.002	0.005	0.003	0.01	0.02	0.01	0.002	0.003	0.002	0.01	0.01	0.01
Ortho-Xylene	0.001	0.002	0.001	0.00	0.01	0.00	0.002	0.004	0.003	0.01	0.01	0.01
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	<0.0005	<0.0005	<0.0005	0.00	0.00	0.00	<0.0005	<0.0005	<0.0005	0.00	0.00	0.00
Total 10 PAHs	0.6825	1.0190	0.8219	0.68*	1.02*	0.82*	0.2718	0.4382	0.3671	0.27*	0.44*	0.37*
Total 7 PCBs	0.003	0.004	0.003	0.05	0.06	0.06	0.000	0.000	0.000	0.00	0.00	0.00
Manganese	25.8	37.4	32.0	0.02	0.02	0.02	34.9	67.5	50.7	0.02	0.05	0.03
Zinc	3.2	7.4	5.1	0.06	0.13	0.09	3.2	6.4	4.7	0.06	0.12	0.09
Copper	2.3	3.8	2.9	0.07	0.12	0.09	0.9	2.2	1.6	0.03	0.07	0.05
Nickel	1.8	3.1	2.6	0.09	0.16	0.13	2.5	4.7	3.5	0.13	0.24	0.17
Cobalt	0.5	0.7	0.6	0.03*	0.04*	0.03*	0.7	1	0.8	0.04*	0.05*	0.04*
Lead	5.8	8.6	6.9	0.01	0.02	0.02	4.8	7.7	6.3	0.02	0.05	0.04
Cadmium	<0.0007	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.03	0.02
Chrome	1.6	2.4	2.1	0.27	0.40	0.34	1.4	2.5	2.0	0.23	0.42	0.34
Mercury	<0.003	<0.003	<0.003	0.00	0.00	0.00	<0.003	<0.003	<0.003	0.00	0.00	0.00

Index	Point number											
	S03-042						S03-043					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	110	267	195	2.20*	5.34*	3.90*	143	511	245	2.86*	10.22*	4.90*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ethylbenzene	<0.001	0.001	0.001	0.00*	0.03*	0.02*	<0.001	0.001	<0.001	0.00*	0.02*	0.01*
∑ meta- and para-Xylene	<0.001	0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Ortho-Xylene	0.004	0.005	0.004	0.01	0.02	0.01	0.004	0.005	0.005	0.01	0.02	0.01
Isopropylbenzene	<0.001	0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0029	0.0038	0.0032	0.15	0.19	0.16	0.0026	0.0049	0.0037	0.13	0.25	0.19
Total 10 PAHs	0.0796	0.1022	0.0894	0.08*	0.10*	0.09*	0.1476	0.1843	0.1655	0.15*	0.18*	0.17*
Total 7 PCBs	0.001	0.001	0.001	0.02	0.02	0.02	0.002	0.002	0.002	0.03	0.03	0.03
Manganese	35.4	44.1	40.5	0.02	0.03	0.03	15.7	23.6	19.8	0.01	0.02	0.01
Zinc	4.3	5.2	4.8	0.08	0.09	0.09	4.3	6.0	5.2	0.08	0.11	0.09
Copper	1.5	2.7	2.0	0.05	0.08	0.06	0.7	1.3	1.0	0.02	0.04	0.03
Nickel	2.4	3.4	2.9	0.12	0.17	0.14	1.2	1.6	1.4	0.06	0.08	0.07
Cobalt	0.4	0.7	0.6	0.02*	0.04*	0.03*	0.2	0.4	0.3	0.01*	0.02*	0.02*
Lead	1.3	1.9	1.6	0.04	0.06	0.05	0.8	1.2	1.0	0.03	0.04	0.03
Cadmium	0.01	0.02	0.01	0.02	0.04	0.02	0.01	0.01	0.01	0.01	0.02	0.02
Chrome	0.6	1.8	1.1	0.10	0.30	0.19	0.7	1.3	1.0	0.12	0.22	0.16
Mercury	<0.003	<0.003	<0.003	0.00	0.00	0.00	<0.003	<0.003	<0.003	0.00	0.00	0.00

5.3.3.2 Air defense base (site 4)

75 soil samples at 15 points of geoecological testing were collected **at site 4 Graham Bell Island (air defense base)** to assess the contamination level.

Assessment according to Russian standards

The content of VAH compounds in soils at the site did not exceed tenths of MPC and amounted to:

- benzene - 0.002 mg/kg (up to 0.01 MPC units),
- toluene - 0.007 mg/kg (up to 0.23 MPC units),
- ∑ meta- and para-xylene - 0.021 mg/kg (up to 0.07 MPC units),
- ortho-xylene - 0.007 mg/kg (up to 0.02 MPC units),
- isopropylbenzene - 0.001 mg/kg (up to 0.003 MPC units).

The content of benz(a)pyrene amounted to 0.0914 mg/kg (up to 4.57 MPC units, point S04-055). The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents.

The content of heavy metals reached:

- manganese - 25.178 mg/kg (up to 16.79 MPC units, point S04-053);
- zinc - 38.7 mg/kg (up to 0.51 APC units, point S04-058);
- copper - 13.8 mg/kg (up to 0.22 APC units, point S04-058);
- nickel - 20.9 mg/kg (up to 0.37 APC units, point S04-058);
- lead - 17.4 mg/kg (up to 0.54 MPC units, point S04-050);
- chrome (mobile form) - up to 5.6 mg/kg (up to 0.93 MPC units, point S04-058);
- cadmium - 0.60 mg/kg (up to 0.80 APC units, point S04-058);
- mercury - 0.005 mg/kg (up to 0.002 MPC units, points S04-050, S04-052, S04-053, S04-058).

The total PCB content reached up to 0.073 mg/kg (up to 1.21 APC units, point S04-052).

Intervals of pollutant content in soils at site's 4 points of geoecological testing in mass concentration values and MPC, APC and PC units are given in Table 5.3-22 at the end of the Section

Table 5.3-21 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards.

Table 5.3-21 Assessment of the levels of soil contamination at the air defense base area (site 4) according to SanPiN 2.1.7.1287-03 and international standards

Index	Site 4									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	2821							1.02	**490***	56.42
Benzene	0.000	0.00	0.01	0.00	permissible	permissible	permissible	0.00	0.04	0.01
Toluene	0.008	0.00	0.23	0.03	permissible	permissible	permissible	0.00	0.14	0.02
Ethylbenzene	0.003							0.00	0.15	0.05
∑ meta- and para-Xylene	0.005	0.00	0.07	0.02	permissible	permissible	permissible	0.00	0.04	0.01
Ortho-Xylene	0.002	0.00	0.02	0.01	permissible	permissible	permissible	0.00	0.01	0.00
Isopropylbenzene	0.000	0.00	0.00	0.00	permissible	permissible	permissible			
Benz(a)pyrene	0.0168	0.00	4.57	0.84	permissible	hazardous	permissible			
Total 10 PAHs	0.6648							0.12	1.45	0.66
Total 7 PCBs	0.014	0.01	1.21	0.23	permissible	permissible	permissible	0.03	3.64	0.70
Manganese	1314.5	0.01	16.79	0.88	permissible	hazardous	permissible			
Zinc	14.9	0.03	0.51	0.17	permissible	permissible	permissible	0.03	0.28	0.11
Copper	3.3	0.00	0.22	0.06	permissible	permissible	permissible	0.01	0.38	0.09
Nickel	4.8	0.02	0.37	0.13	permissible	permissible	permissible	0.01	0.60	0.14
Cobalt	1.0							0.01	0.13	0.05
Lead	6.1	0.03	0.54	0.19	permissible	permissible	permissible	0.01	0.20	0.07
Cadmium	0.10	0.01	0.80	0.13	permissible	permissible	permissible	0.01	0.75	0.13
Chrome	2.3	0.10	0.93	0.38	permissible	permissible	permissible	0.01	0.06	0.02
Mercury	0.001	0.00	0.00	0.00	permissible	permissible	permissible	0.00	0.02	0.00
Zc metals	8.27						permissible			

Note: * - values exceed the intervention level (IL)

In terms of the average content of all the substances to be analyzed site's 4 soil belongs to the **permissible** contamination class

The values of the total soil pollution index Zc calculated for a series of metals varied from 6.50 (**permissible** contamination class) to 160.6 (**extra-hazardous** contamination class), while the average value for the site was 8.27 (**permissible** contamination class). At the same time, at testing point S04-053, the MPC for manganese was exceeded to correspond tothe **extra-hazardous** soil contamination class.

In general, the level of soil contamination at the surveyed area of the settlement can be assessed as **hazardous.**

Assessment according to international standards

Permissible concentrations (PC) of oil products, total PAHs and total PCBs were exceeded in the site's soils at separate points, including:

- oil products - up to 490 PC units;
- total PAHs – up to 1.5 PC units;
- total PCBs – up to 3.6 PC units.

In general, the average content of pollutants for the site exceeds the PC values as follows: oil products – 56.4 times.

It is necessary to pay special attention to the fact that the level of soil contamination with oil products **exceeds the intervention level** in the values at separate points of geoecological testing (up to 5 IL)

Figures 5.3-31 – 5.3-34 show spatial characteristics of the level of site's 4 soil contamination with oil products, total PAHs, total PCBs in PC units and integrated pollution with heavy metals in Zc units

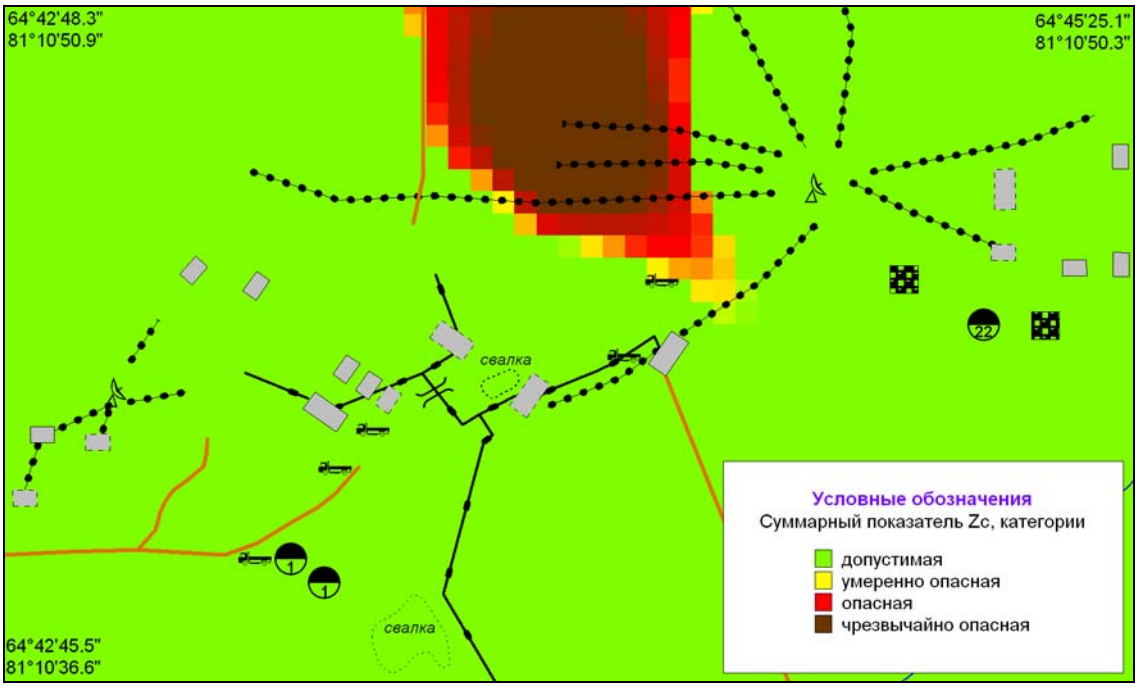


Figure 5.3-31 Spatial characteristics of the level of soil contamination of the air defense base area (site 4) with a series of heavy metals (Zc)

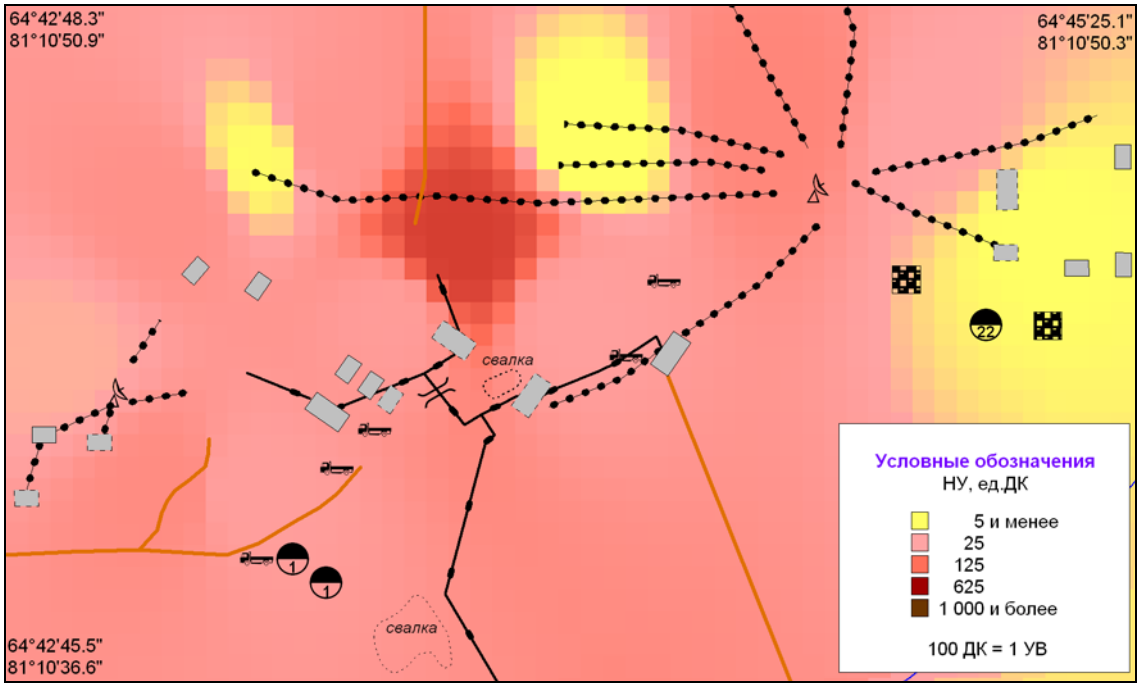
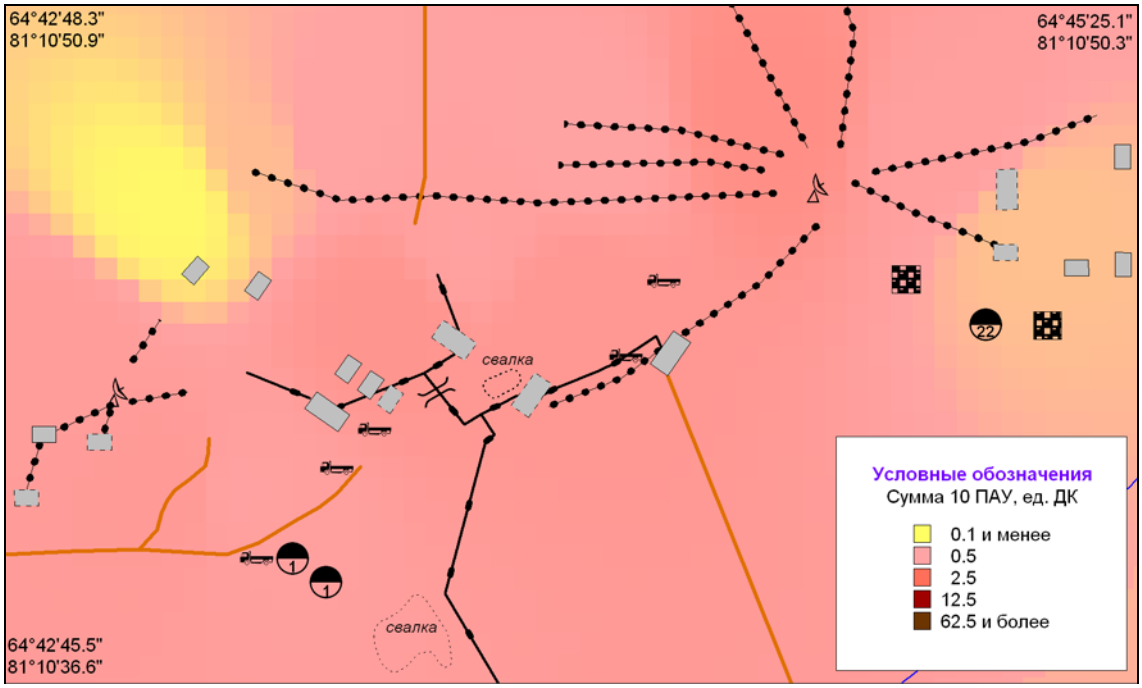
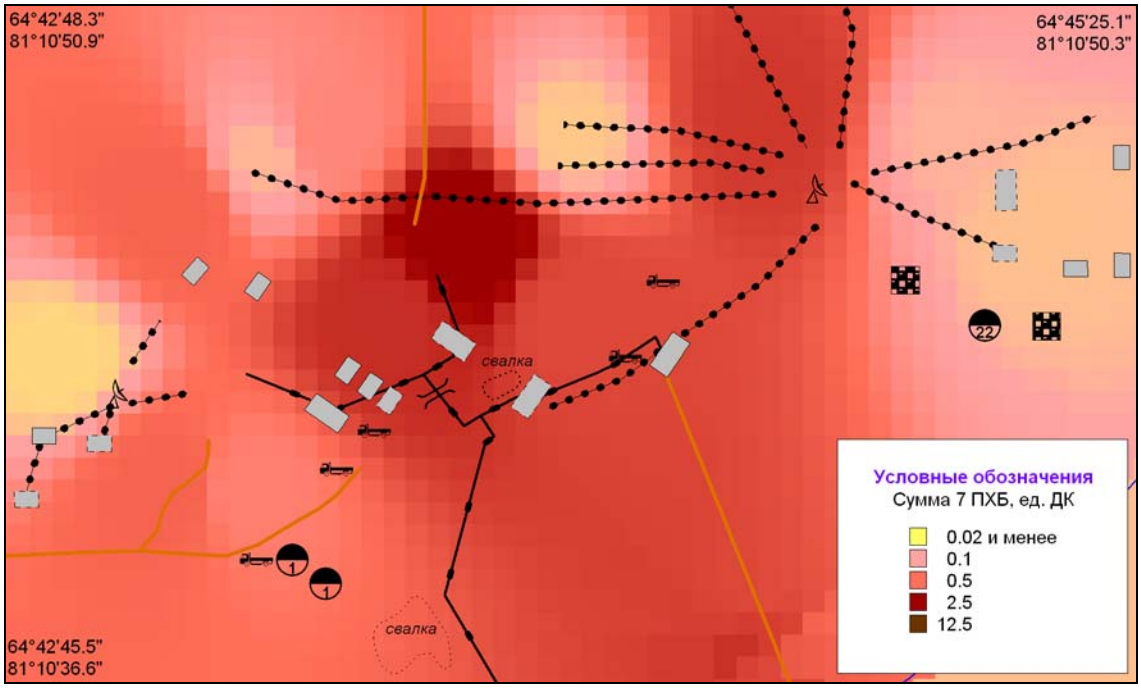


Figure 5.3-32 Spatial characteristics of the level of soil contamination of air defense base area (site 4) with petroleum hydrocarbons (oil products)



Note: Total 10 PAHs - anthracene, benz(a)anthracene, benz(k)fluoranthene, benz(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(123cd)pyrene, naphthalene, benz(ghi)perylene

Figure 5.3-33 Spatial characteristics of the level of soil contamination of air defense base area (site 4) with polycyclic aromatic hydrocarbons



Note: Total 7 PCBs - # 28, # 52, # 101, # 118, # 138, # 153, # 180

Figure 5.3-34 Spatial characteristics of the level of soil contamination of the air defense base area (site 4) with polychlorinated biphenyls

Table 5.3-22 Content of pollutants in the intervals of mass concentration and MPC, APC and PC units in soils at site's 4 points

Index	Point number											
	S04-044						S04-045					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	1243	3985	2599	24.86*	79.70*	51.99*	95	460	274	1.90*	9.20*	5.48*
Benzene	<0.001	0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	0.010	0.015	0.013	0.03	0.05	0.04	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ethylbenzene	0.005	0.007	0.006	0.10*	0.14*	0.12*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.016	0.021	0.019	0.05	0.07	0.06	0.001	0.003	0.002	0.00	0.01	0.01
Ortho-Xylene	0.005	0.007	0.006	0.02	0.02	0.02	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	<0.0005	<0.0005	<0.0005	0.00	0.00	0.00	0.0114	0.0146	0.0128	0.57	0.73	0.64
Total 10 PAHs	0.4049	0.6355	0.5241	0.40*	0.64*	0.52*	0.3315	0.4371	0.3933	0.33*	0.44*	0.39*
Total 7 PCBs	0.006	0.007	0.006	0.10	0.12	0.11	0.002	0.002	0.002	0.03	0.03	0.03
Manganese	27.6	67.0	49.5	0.02	0.04	0.03	51.5	95.8	76.1	0.03	0.06	0.05
Zinc	6.3	12.4	9.3	0.03	0.06	0.04	12.3	21.2	16.9	0.22	0.39	0.31
Copper	0.7	1.6	1.2	0.01	0.01	0.01	1	1.6	1.2	0.03	0.05	0.04
Nickel	3	5.8	4.4	0.04	0.07	0.06	3.1	5.4	4.3	0.16	0.27	0.21
Cobalt	0.2	0.3	0.2	0.01*	0.02*	0.01*	0.3	0.4	0.4	0.02*	0.02*	0.02*
Lead	2.1	4.5	3.7	0.07	0.14	0.12	2.3	3.7	3.2	0.07	0.12	0.10
Cadmium	0.01	0.03	0.02	0.01	0.01	0.01	0.01	0.03	0.02	0.03	0.06	0.04
Chrome	0.7	1.2	1.0	0.12	0.20	0.17	1.2	2.6	2.0	0.20	0.43	0.34
Mercury	<0.003	0.003	<0.003	0.00	0.00	0.00	<0.003	<0.003	<0.003	0.00	0.00	0.00

Index	Point number											
	S04-046						S04-047					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	482	5763	3029	9.64*	115.26*	60.58*	624	1794	1116	12.48*	35.88*	22.32*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	0.005	0.007	0.005	0.02	0.02	0.02	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ethylbenzene	0.004	0.006	0.005	0.08*	0.12*	0.10*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.003	0.005	0.004	0.01	0.02	0.01	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ortho-Xylene	0.002	0.003	0.003	0.01	0.01	0.01	0.003	0.004	0.004	0.01	0.01	0.01
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0047	0.0082	0.0064	0.24	0.41	0.32	0.0104	0.0149	0.0131	0.52	0.75	0.66
Total 10 PAHs	0.1168	0.1473	0.1325	0.12*	0.15*	0.13*	0.7059	0.8284	0.7523	0.71*	0.83*	0.75*
Total 7 PCBs	0.013	0.014	0.014	0.21	0.24	0.23	0.001	0.001	0.001	0.02	0.02	0.02
Manganese	56.6	90.1	70.8	0.04	0.06	0.05	69.5	143.7	101.8	0.05	0.10	0.07
Zinc	7.5	12.9	10.5	0.14	0.23	0.19	5.8	11.4	8.3	0.11	0.21	0.15
Copper	2.1	3.6	2.6	0.06	0.11	0.08	0.4	1.2	0.9	0.01	0.04	0.03
Nickel	1.1	2.2	1.7	0.06	0.11	0.08	1.8	4.2	3.0	0.09	0.21	0.15
Cobalt	0.6	0.7	0.6	0.03*	0.04*	0.03*	0.6	0.8	0.7	0.03*	0.04*	0.03*
Lead	5.6	9.8	8.2	0.18	0.31	0.26	4.6	9.2	7.4	0.14	0.29	0.23
Cadmium	0.01	0.01	0.01	0.01*	0.03*	0.02*	0.07	0.10	0.08	0.14*	0.19*	0.16*
Chrome	1.3	3.1	2.4	0.22	0.52	0.40	1.2	2.8	2.2	0.20	0.47	0.36
Mercury	0.003	0.004	0.003	0.00	0.00	0.00	<0.003	0.003	<0.003	0.00	0.00	0.00

Continuation of Table 5.3-22

Index	Point number											
	S04-048						S04-049					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	1822	5047	3423	36.44*	100.94*	68.46*	1588	6134	3559	31.76*	122.68*	71.18*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Toluene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.002	0.005	0.004	0.01	0.02	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0. 00*	0. 00*
∑ meta- and para-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.002	0.003	0.002	0.01	0.01	0.01
Ortho-Xylene	0.003	0.004	0.004	0.01	0.01	0.01	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0075	0.0098	0.0087	0.38	0.49	0.44	0.0051	0.0101	0.0076	0.26	0.51	0.38
Total 10 PAHs	0.7449	1.0142	0.8403	0.74*	1.01*	0.84*	0.7572	1.0011	0.8680	0.76*	1.00*	0.87*
Total 7 PCBs	0.016	0.020	0.018	0.27	0.33	0.30	0.009	0.011	0.010	0.15	0.19	0.16
Manganese	159.8	226.5	190.0	0.11	0.15	0.13	75.5	117.3	91.4	0.05	0.08	0.06
Zinc	7.4	18	13.0	0.03	0.08	0.06	9.8	18.7	14.9	0.04	0.09	0.07
Copper	1.6	2.7	2.1	0.01	0.02	0.02	0.6	1.4	1.1	0.00	0.01	0.01
Nickel	2.5	5.3	4.0	0.03	0.07	0.05	1.9	4.1	3.2	0.02	0.05	0.04
Cobalt	0.8	1	0.9	0.04*	0.05*	0.05*	0.6	0.8	0.7	0.03*	0.04*	0.03*
Lead	5.3	7.8	6.9	0.17	0.24	0.22	11.3	16.9	14.2	0.35	0.53	0.44
Cadmium	0.07	0.15	0.11	0.03	0.07	0.06	0.05	0.08	0.07	0.03	0.04	0.03
Chrome	1.1	1.5	1.3	0.18	0.25	0.22	0.9	2.4	1.8	0.15	0.40	0.30
Mercury	<0.003	<0.003	<0.003	0.00	0.00	0.00	<0.003	<0.003	<0.003	0.00	0.00	0.00

Index	Point number											
	S04-050						S04-051					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	1250	2462	1722	25.00*	49.24*	34.44*	920	2974	1973	18.40*	59.48*	39.46*
Benzene	0.001	0.002	0.001	0.00	0.01	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.010	0.014	0.013	0.03	0.05	0.04	0.013	0.016	0.014	0.04	0.05	0.05
Ethylbenzene	0.004	0.006	0.005	0.08*	0.11*	0.09*	0.003	0.005	0.004	0.05*	0.10*	0.08*
∑ meta- and para-Xylene	0.001	0.002	0.002	0.00	0.01	0.01	0.002	0.003	0.003	0.01	0.01	0.01
Ortho-Xylene	0.002	0.002	0.002	0.01	0.01	0.01	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0024	0.0041	0.0034	0.12	0.21	0.17	0.0005	0.0009	0.0007	0.03	0.05	0.04
Total 10 PAHs	0.4426	0.7172	0.6055	0.44*	0.72*	0.61*	0.9770	1.1495	1.0531	0.98*	1.15*	1.05*
Total 7 PCBs	0.007	0.008	0.007	0.11	0.13	0.12	0.031	0.036	0.033	0.51	0.60	0.56
Manganese	205	283.0	232.4	0.14	0.19	0.15	312.8	477.3	398.1	0.21	0.32	0.27
Zinc	12.9	16.6	14.2	0.23	0.30	0.26	12.2	20.9	15.8	0.06	0.10	0.07
Copper	2.7	4.6	3.7	0.08	0.14	0.11	2.4	3.5	3.1	0.02	0.03	0.02
Nickel	5.8	7.4	6.4	0.29	0.37	0.32	4.9	9.4	7.4	0.06	0.12	0.09
Cobalt	1.2	2.6	2.1	0.06*	0.13*	0.10*	1.3	1.7	1.5	0.07*	0.09*	0.08*
Lead	10.4	17.4	14.7	0.33	0.54	0.46	4.7	10.6	8.4	0.15	0.33	0.26
Cadmium	0.03	0.05	0.04	0.06	0.10	0.08	0.06	0.09	0.07	0.03	0.05	0.04
Chrome	1.9	2.7	2.3	0.32	0.45	0.38	1.1	2.3	1.8	0.18	0.38	0.31
Mercury	<0.003	0.005	<0.003	0.00	0.00	0.00	<0.003	0.003	<0.003	0.00	0.00	0.00

Continuation of Table 5.3-22

Index	Point number											
	S04-052						S04-053					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	9923	24500	17067	198.46*	490.00*	341.33*	50.8	136	87	1.02*	2.72*	1.75*
Benzene	0.001	0.002	0.001	0.001	0.01	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.009	0.015	0.012	0.009	0.05	0.04	0.012	0.015	0.013	0.04	0.05	0.04
Ethylbenzene	0.004	0.006	0.005	0.004	0.13*	0.11*	0.002	0.005	0.004	0.04*	0.10*	0.08*
∑ meta- and para-Xylene	0.008	0.013	0.010	0.008	0.04	0.03	0.005	0.008	0.007	0.02	0.03	0.02
Ortho-Xylene	0.001	0.003	0.002	0.001	0.01	0.01	0.002	0.002	0.002	0.01	0.01	0.01
Isopropylbenzene	<0.001	<0.001	<0.001	<0.001	0.00	0.00	0.001	0.001	0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0086	0.0101	0.0094	0.0086	0.51	0.47	0.0249	0.0356	0.0321	1.25	1.78	1.60
Total 10 PAHs	0.4735	0.6848	0.6061	0.4735	0.68*	0.61*	0.3678	0.6758	0.5408	0.37*	0.68*	0.54*
Total 7 PCBs	0.055	0.073	0.060	0.055	1.21	1.01	0.001	0.002	0.001	0.02	0.03	0.02
Manganese	207.4	344.7	288.8	0.14	0.23	0.19	12635	25178.0	17470.6	8.42	16.79	11.65
Zinc	12.6	18.4	15.0	0.23	0.33	0.27	23.5	35.1	29.7	0.11	0.16	0.14
Copper	1.9	4.2	3.2	0.06	0.13	0.10	5.9	8.2	7.0	0.04	0.06	0.05
Nickel	2.8	5.6	4.7	0.14	0.28	0.24	6.3	10	7.6	0.08	0.13	0.10
Cobalt	1.7	2.1	1.9	0.09*	0.11*	0.09*	1.7	2.5	2.2	0.09*	0.13*	0.11*
Lead	2.8	6.2	5.0	0.09	0.19	0.16	2.1	3.5	2.8	0.07	0.11	0.09
Cadmium	0.06	0.10	0.08	0.13	0.20	0.17	0.04	0.07	0.05	0.02	0.04	0.03
Chrome	1.9	2.8	2.3	0.32	0.47	0.38	2.6	5.4	3.6	0.43	0.90	0.59
Mercury	0.004	0.005	0.004	0.00	0.00	0.00	<0.003	0.005	<0.003	0.00	0.00	0.00

Index	Point number											
	S04-054						S04-055					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	835	1934	1254	16.70*	38.68*	25.08*	2053	5283	4029	41.06*	105.66*	80.58*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.001	0.002	0.001	0.00	0.01	0.00
Toluene	0.002	0.002	0.002	0.01	0.01	0.01	<0.001	0.001	<0.001	0.00	0.00	0.00
Ethylbenzene	0.003	0.006	0.005	0.06*	0.11*	0.09*	0.005	0.008	0.006	0.09*	0.15*	0.12*
∑ meta- and para-Xylene	0.005	0.012	0.010	0.02	0.04	0.03	0.005	0.011	0.009	0.02	0.04	0.03
Ortho-Xylene	0.002	0.002	0.002	0.01	0.01	0.01	0.002	0.003	0.003	0.01	0.01	0.01
Isopropylbenzene	<0.001	0.001	0.000	0.00	0.00	0.00	<0.001	0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0042	0.0071	0.0054	0.21	0.36	0.27	0.0578	0.0914	0.0772	2.89	4.57	3.86
Total 10 PAHs	0.5498	0.7326	0.6531	0.55*	0.73*	0.65*	1.0908	1.4457	1.2847	1.09*	1.45*	1.28*
Total 7 PCBs	0.002	0.002	0.002	0.03	0.03	0.03	0.026	0.032	0.029	0.43	0.53	0.49
Manganese	242.3	413.2	307.8	0.16	0.28	0.21	56.9	163.6	110.6	0.04	0.11	0.07
Zinc	12.4	27.8	19.2	0.23	0.51	0.35	6.4	13.5	10.1	0.12	0.25	0.18
Copper	3.0	7.1	4.8	0.09	0.22	0.14	1.1	2.7	2.0	0.03	0.08	0.06
Nickel	2.5	4.6	3.6	0.13	0.23	0.18	0.5	2.6	1.3	0.03	0.13	0.07
Cobalt	0.8	1.0	0.9	0.04*	0.05*	0.04*	0.3	0.4	0.4	0.02*	0.02*	0.02*
Lead	1.7	3.2	2.6	0.05	0.10	0.08	1.8	3.9	3.1	0.06	0.12	0.10
Cadmium	0.07	0.12	0.11	0.14	0.25	0.21	0.09	0.12	0.11	0.19	0.25	0.21
Chrome	3.0	5.6	4.5	0.50	0.93	0.75	1.0	1.5	1.2	0.17	0.25	0.19
Mercury	<0.003	0.003	<0.003	0.00	0.00	0.00	<0.003	<0.003	<0.003	0.00	0.00	0.00

Continuation of Table 5.3-22

Index	Point number											
	S04-056						S04-057					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	126	572	360	2.52*	11.44*	7.20*	57	281	135	1.14*	5.62*	2.71*
Benzene	0.001	0.002	0.002	0.00	0.01	0.01	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.011	0.016	0.013	0.04	0.05	0.04	0.002	0.005	0.003	0.01	0.02	0.01
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.004	0.006	0.005	0.01	0.02	0.02	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ortho-Xylene	0.003	0.003	0.003	0.01	0.01	0.01	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0051	0.0069	0.0059	0.26	0.35	0.30	0.0010	0.0016	0.0014	0.05	0.08	0.07
Total 10 PAHs	0.2221	0.3653	0.2965	0.22*	0.37*	0.30*	0.3569	0.5333	0.4459	0.36*	0.53*	0.45*
Total 7 PCBs	0.002	0.002	0.002	0.03	0.04	0.04	0.001	0.001	0.001	0.01	0.01	0.01
Manganese	85.2	121.0	100.3	0.06	0.08	0.07	10.7	15.5	12.5	0.01	0.01	0.01
Zinc	9.3	13.9	11.9	0.17	0.25	0.22	3.6	5.2	4.4	0.07	0.09	0.08
Copper	3.5	4.1	3.8	0.11	0.12	0.11	0.7	1.3	0.9	0.02	0.04	0.03
Nickel	2.5	3.7	3.0	0.13	0.19	0.15	1.0	2.0	1.5	0.05	0.10	0.07
Cobalt	0.4	1.0	0.7	0.02*	0.05*	0.03*	0.2	0.3	0.3	0.01*	0.02*	0.01*
Lead	3.0	4.1	3.5	0.09	0.13	0.11	0.9	1.3	1.1	0.03	0.04	0.03
Cadmium	0.09	0.40	0.24	0.18	0.80	0.48	0.02	0.10	0.06	0.04	0.20	0.11
Chrome	1.1	2.6	1.9	0.18	0.43	0.32	0.6	1.4	1.0	0.10	0.23	0.17
Mercury	<0.003	<0.003	<0.003	0.00	0.00	0.00	<0.003	<0.003	<0.003	0.00	0.00	0.00

Index	Point number					
	S04-058					
	Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.
Oil products	935	2573	1685	18.70*	51.46*	33.69*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	0.003	0.070	0.021	0.01	0.23	0.07
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	0.001	0.002	0.002	0.00	0.01	0.00
Ortho-Xylene	0.001	0.001	0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0526	0.0839	0.0681	2.63	4.20	3.40
Total 10 PAHs	0.7680	1.1128	0.9761	0.77*	1.11*	0.98*
Total 7 PCBs	0.022	0.025	0.024	0.37	0.42	0.40
Manganese	176	259.0	216.4	0.12	0.17	0.14
Zinc	22.6	38.7	29.8	0.10	0.18	0.14
Copper	9.5	13.8	11.7	0.07	0.10	0.09
Nickel	12.2	20.9	15.9	0.15	0.26	0.20
Cobalt	0.7	1.6	1.3	0.04*	0.08*	0.07*
Lead	5.7	7.1	6.5	0.18	0.22	0.20
Cadmium	0.30	0.60	0.46	0.15	0.30	0.23
Chrome	4.4	5.6	5.0	0.73	0.93	0.83
Mercury	<0.003	0.005	0.003	0.00	0.00	0.00

5.3.3.3 Drum storage facility on the coast (Site 5)

15 soil samples at 3 points of geoecological testing were collected **at site 5 on Graham Bell Island (drum storage facility on the coast).**

Assessment according to Russian standards

The content of VAH compounds in soils at the site did not exceed tenths of MPC and amounted to:

- toluene - 0.008 mg/kg (up to 0.03 MPC units);
- ∑ meta- and para-xylene - 0.006 mg/kg (up to 0.02 MPC units).

The concentration of benzene, ortho-xylene and isopropylbenzene did not exceed the lowest detection limit of the analysis technique.

The content of benz(a)pyrene amounted to 0.0182 mg/kg (up to 0.91 MPC units, point S05-059). The content of other PAH compounds to be analyzed is not standardized by Russian regulatory documents.

The content of heavy metals reached:

- manganese - 215.4 mg/kg (up to 0.14 MPC units, point S05-059);
- zinc - 89.6 mg/kg (up to 1.63 APC units, point S05-060);
- copper - 16 mg/kg (up to 0.48 APC units, point S05-059);
- nickel - 13.5 mg/kg (up to 0.68 APC units, point S05-060);
- lead - 40.6 mg/kg (up to 1.27 MPC units, point S05-060);
- chrome (mobile form) – 7.6 mg/kg (up to 1.27 MPC units, point S05-060);
- cadmium - 0.14 mg/kg (up to 0.28 APC units, point S05-059);
- mercury - 0.005 mg/kg (up to 0.002 MPC units, point S05-060).

The total PCB content reached 0.012 mg/kg (up to 0.20 APC units, point S05-061).

Intervals of pollutant content in soils at site's 5 points of geoecological testing in mass concentration values and MPC, APC and PC units are given in Table 5.3-24 at the end of the Section.

Table 5.3-23 contains the assessment of the site's soil contamination (contamination class) performed according to the requirements of SanPiN 2.1.7.1287-03 based on MPC (APC), and the levels of contamination in PC units according to international standards

Table 5.3-23 Assessment of the levels of soil contamination at drum storage facility on the coast area (site 5) according to SanPiN 2.1.7.1287-03 and international standards

Index	Site 5									
	Values, mg/kg	Values in MPC (APC) units			Contamination class			Values in PC units		
	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	567							2.06	24.96	11.33
Benzene	<0.001	0.00	0.00	0.00	permissible	permissible	permissible	0.00	0.00	0.00
Toluene	0.002	0.00	0.03	0.01	permissible	permissible	permissible	0.00	0.02	0.00
Ethylbenzene	<0.001							0.00	0.08	0.02
∑ meta- and para-Xylene	0.001	0.00	0.02	0.00	permissible	permissible	permissible	0.00	0.01	0.00
Ortho-Xylene	<0.001	0.00	0.00	0.00	permissible	permissible	permissible	0.00	0.00	0.00
Isopropylbenzene	<0.001	0.00	0.00	0.00	permissible	permissible	permissible			
Benz(a)pyrene	0.0058	0.00	0.91	0.29	permissible	permissible	permissible			
Total 10 PAHs	0.5204							0.35	0.74	0.52
Total 7 PCBs	0.009	0.07	0.20	0.15	permissible	permissible	permissible	0.21	0.60	0.44
Manganese	114.3	0.05	0.14	0.08	permissible	permissible	permissible			
Zinc	47.3	0.41	1.63	0.86	permissible	hazardous	permissible	0.16	0.64	0.34
Copper	8.8	0.12	0.48	0.27	permissible	permissible	permissible	0.11	0.44	0.24
Nickel	6.6	0.10	0.68	0.33	permissible	permissible	permissible	0.06	0.39	0.19
Cobalt	0.9							0.03	0.07	0.05
Lead	16.8	0.16	1.27	0.53	permissible	hazardous	permissible	0.06	0.48	0.20
Cadmium	0.06	0.02	0.28	0.12	permissible	permissible	permissible	0.01	0.17	0.08
Chrome	4.6	0.42	1.27	0.77	permissible	extra-hazardous	permissible	0.03	0.08	0.05
Mercury	<0.003	0.00	0.00	0.00	permissible	permissible	permissible	0.00	0.02	0.01
Zc metals	0.39						permissible			

Note: * - values exceed the intervention level (IL)

In terms of the average content of all the substances to be analyzed site's 5 soil belongs to the **permissible** contamination class.

The values of the total soil pollution index Zc calculated for a series of metals varied from 3.16 to 4.42 while the average value for the site was 0.4 to correspond to the **permissible** contamination class.

At the same time, at testing point S05-060, the MPC for chrome and Kmax values (according to Methodological Guidelines 2.1.7.730-99) were exceeded to correspond to the **extra-hazardous** soil contamination class

In general, the level of soil contamination at the surveyed area of the drum storage facility on the coast can be assessed as **hazardous.**

Assessment according to international standards

Permissible concentrations (PC) of oil products in the site's 5 soils were exceeded; at separate points of testing, they reached up to 25 PC units; the average content reached up to 11.3 PC units. The intervention level has not been reached.

Figures 5.3-35 – 5.3-38 show spatial characteristics of the level of site's 5 soil contamination with oil products, total PAHs, total PCBs in PC units and integrated pollution with heavy metals in Zc units

Figure 5.3-35 Spatial characteristics of the level of soil contamination of the drum storage facility on the coast area (site 5) with a series of heavy metals (Zc)

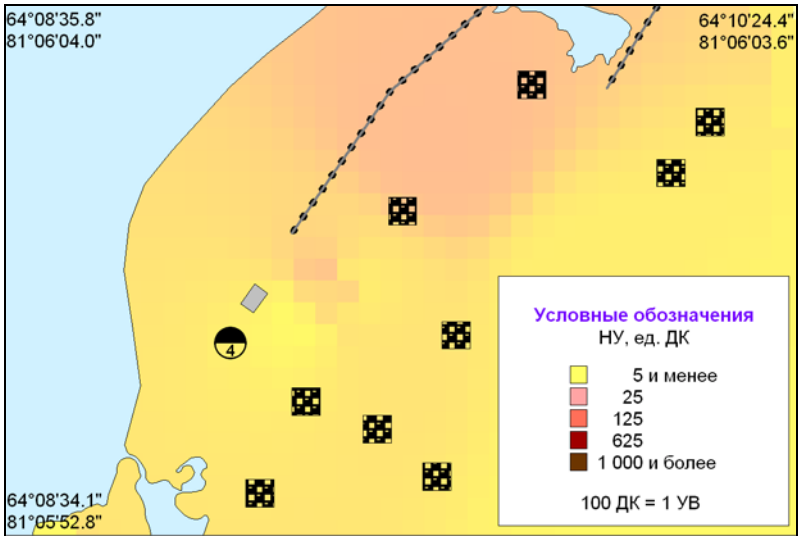
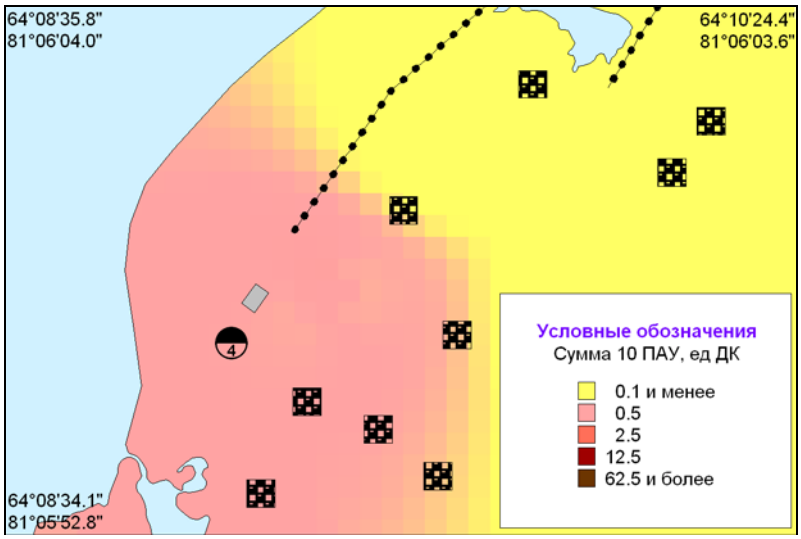
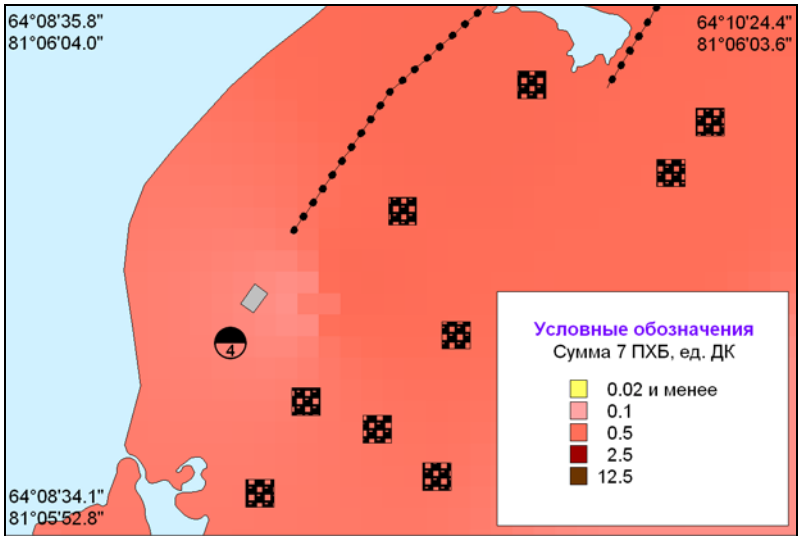


Figure 5.3-36 Spatial characteristics of the level of soil contamination of the drum storage facility on the coast area (site 5) with petroleum hydrocarbons (oil products)



Note: Total 10 PAHs - anthracene, benz(a)anthracene, benz(k)fluoranthene, benz(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(123cd)pyrene, naphthalene, benz(ghi)perylene

Figure 5.3-37 Spatial characteristics of the level of soil contamination of the drum storage facility on the coast area (site 5) with polycyclic aromatic hydrocarbons



Note: Total 7 PCBs - # 28, # 52, # 101, # 118, # 138, # 153, # 180

Figure 5.3-38 Spatial characteristics of the level of soil contamination of the drum storage facility on the coast area (site 5) with polychlorinated biphenyls

Table 5.3-24 Content of pollutants in the intervals of mass concentration and MPC, APC and PC units in soils at site's 5 points

Index	Point number											
	S05-059						S05-060					
	Values, mg/kg			Values in MPC (APC), *PC units			Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.	min	max	aver.	min	max	aver.
Oil products	103	519	313	2.06*	10.38*	6.25*	566	1248	954	11.32*	24.96*	19.08*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	<0.001	0.001	<0.001	0.00	0.00	0.00	0.006	0.008	0.007	0.02	0.03	0.02
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*	0.002	0.004	0.003	0.03*	0.08*	0.05*
∑ meta- and para-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	0.003	0.006	0.004	0.01	0.02	0.01
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	0.0130	0.0182	0.0162	0.65	0.91	0.81	0.0008	0.0014	0.0012	0.04	0.07	0.06
Total 10 PAHs	0.4435	0.5209	0.4693	0.44*	0.52*	0.47*	0.5300	0.7419	0.6452	0.53*	0.74*	0.65*
Total 7 PCBs	0.004	0.005	0.005	0.07	0.08	0.08	0.010	0.011	0.011	0.16	0.19	0.18
Manganese	122.3	215.4	167.3	0.08	0.14	0.11	87.6	112.0	101.0	0.06	0.07	0.07
Zinc	22.4	43.1	34.8	0.41	0.78	0.63	76.1	89.6	81.6	1.38	1.63	1.48
Copper	8.4	16	12.2	0.25	0.48	0.37	8.2	11.3	9.7	0.25	0.34	0.29
Nickel	2.0	3.0	2.3	0.10	0.15	0.12	10.1	13.5	11.7	0.51	0.68	0.58
Cobalt	0.8	1.0	0.9	0.04*	0.05*	0.04*	0.6	1.3	1.0	0.03*	0.07*	0.05*
Lead	5.0	12.5	10.4	0.16	0.39	0.32	26.8	40.6	34.2	0.84	1.27	1.07
Cadmium	0.09	0.14	0.11	0.18	0.28	0.23	0.01	0.06	0.03	0.02	0.12	0.05
Chrome	3.6	5.0	4.3	0.60	0.83	0.71	5.4	7.6	6.6	0.90	1.27	1.10
Mercury	0.003	0.004	0.004	0.00	0.00	0.00	<0.003	0.005	<0.003	0.00	0.00	0.00

Index	Point number					
	S05-061					
	Values, mg/kg			Values in MPC (APC), *PC units		
	min	max	aver.	min	max	aver.
Oil products	265	672	434	5.30*	13.44*	8.68*
Benzene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Toluene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ethylbenzene	<0.001	<0.001	<0.001	0.00*	0.00*	0.00*
∑ meta- and para-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Ortho-Xylene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Isopropylbenzene	<0.001	<0.001	<0.001	0.00	0.00	0.00
Benz(a)pyrene	<0.0005	<0.0005	<0.0005	0.00	0.00	0.00
Total 10 PAHs	0.3506	0.4925	0.4466	0.35*	0.49*	0.45*
Total 7 PCBs	0.010	0.012	0.011	0.17	0.20	0.18
Manganese	71.6	78.4	74.5	0.05	0.05	0.05
Zinc	23.7	27.9	25.6	0.43	0.51	0.46
Copper	3.8	5.3	4.6	0.12	0.16	0.14
Nickel	4.9	6.4	5.7	0.25	0.32	0.29
Cobalt	0.6	1.3	0.9	0.03*	0.07*	0.04*
Lead	5.4	6.3	5.9	0.17	0.20	0.18
Cadmium	0.01	0.08	0.04	0.02	0.16	0.09
Chrome	2.5	3.5	3.0	0.42	0.58	0.49
Mercury	<0.003	0.004	<0.003	0.00	0.00	0.00

5.3.3.4 Comparative analysis of the level of contamination of the sites on Graham Bell Island

A comparative analysis of soil contamination at the surveyed sites allows us to make the following conclusion:

- In terms of the content of **petroleum hydrocarbons**, the most contaminated soils are located in the aviation camp (site 2), for which the average concentration of petroleum hydrocarbons **1.9 times** exceeds the **intervention level** according to international standards;
- Site's 2 soils are the most contaminated with **polycyclic aromatic hydrocarbon** compounds. The average concentration of PAHs (in total) **4.7 times** exceeds the PC international standards, while in terms of the content of **benz(a)pyrene** the site's soils belong to the **extra-hazardous** contamination class according to SanPiN 2.1.7.1287-03;
- The highest levels of the content of **polychlorinated biphenyls** were detected in soils in the vicinity of the aviation camp and air defense base (sites 2 and 4). At the same time, none of the surveyed sites had the average concentration of PCBs in soils reaching **MPC** and **PC** to correspond tothe **permissible** contamination class according to SanPiN 2.1.7.1287-03;
- . The contamination of soils at all the surveyed sites with a series of **heavy metals** (according to Zc index) corresponded to the **permissible** contamination class according to SanPiN 2.1.7.1287-03.

In general, the level of soil contamination at the surveyed sites can be assessed as follows:

- **extra-hazardous** for the aviation camp area (site 2);
- **permissible** for the landing strip area (site 3);
- **hazardous** for the air defense base area (site 4);
- **hazardous** for the drum storage facility on the coast area (site 5).

Figure 5.3-39 shows the comparative analysis of the average content of pollutants in soils of the surveyed areas on Graham Bell Island

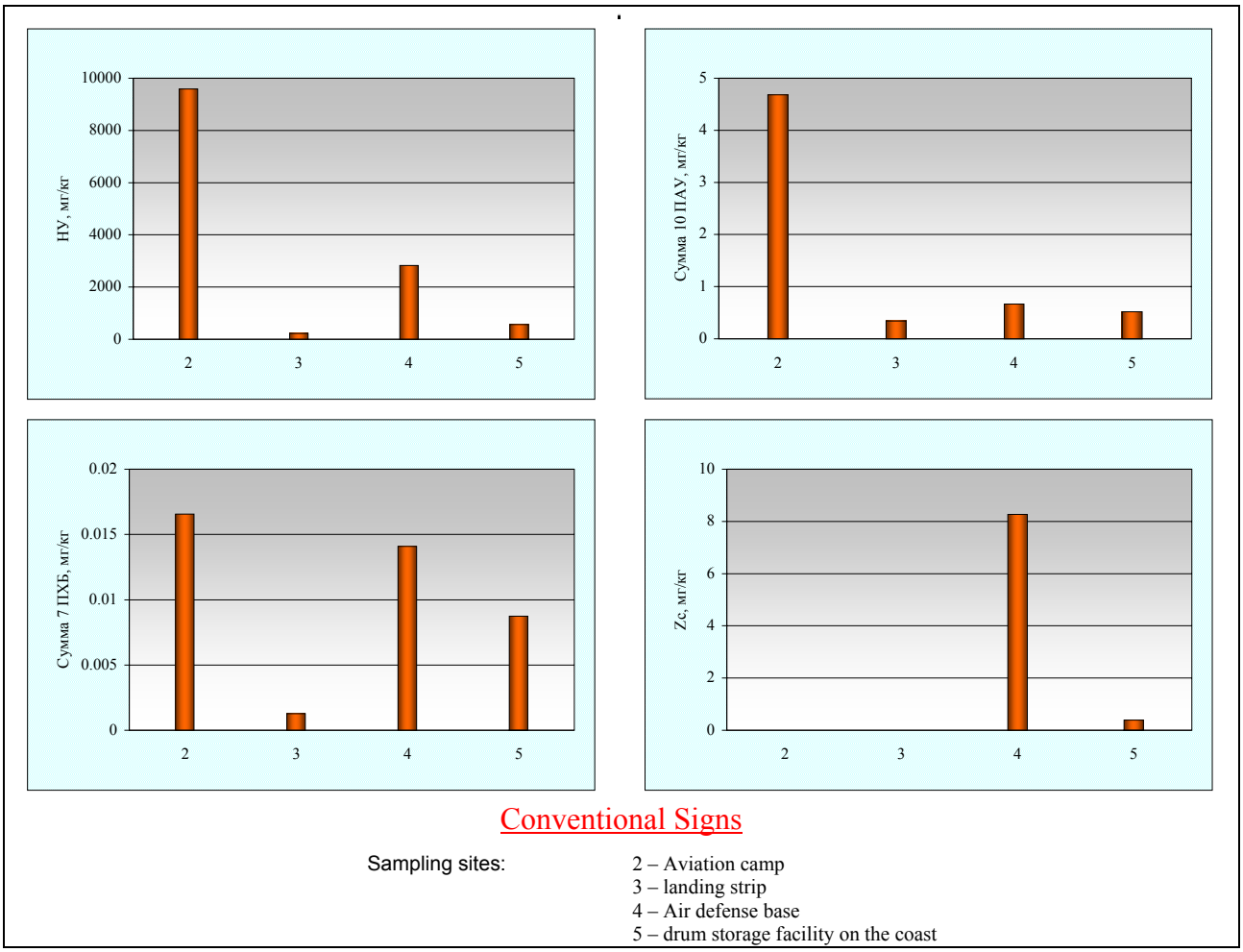


Figure 5.3-39 Average values of the total pollution index Zc and average values petroleum hydrocarbons, PAH and PCB concentrations at the surveyed sites on Graham Bell Island

5.4 Results of technical liquids study

The objective of the study of technical liquids from the tanks from Alexandra and Graham Bell Islands was to detect the presence of unaccounted stocks of organic products based on polychlorinated biphenyls such as sovols, sovtols and hexanols. The investigation included the study of the area of storage facilities, appearance of the containers, marking and appearance of the liquids, the identification of oil products based on laboratory control of physico-chemical characteristics and the parameters of composition and properties of various types of oil products according to GOSTs and Specifications, the determination of polychlorinated biphenyls content in collected samples. In conformance with the objectives of work, the specimens of oil products, which were unambiguously identified on site as gasoline, kerosene and diesel fuel were not collected.

The results of external examination of technical liquid storage facilities, containers, marking and organoleptic parameters are given in Table 5.4-1.

Table 5.4-1 Characteristics of technical liquid specimens from the sites of Alexandra and Graham Bell Islands

Number of sample	Location	Type of tank	Presence of the stamp and label	Visual characteristics of the specimen
Alexandra Island				
L01-01	Dump of drums and operating fuel and lubricant storage facility on the coast	200 l iron drum	Stamp of 1981	Thick light brown liquid with oil odor
L01-02	Dump of drums and operating fuel and lubricant storage facility on the coast	200 l iron drum	-	Thick light brown liquid with oil odor
L01-03	Dump of drums and operating fuel and lubricant storage facility on the coast	200 l iron drum	-	Thick light brown liquid with oil odor
L09-12	Radar station	Radar transformer mechanism	-	Yellow-brown liquid with oil odor
L09-13	Radar station	200 l metallic drum	Label “1-БК”	Brown liquid with oil odor
L09-14	Radar station	200 l metallic drum	Stamp of 1981	Brown liquid with oil odor
L09-15	Radar station	200 l metallic drum	-	Brown liquid with oil odor
L09-16	Radar station	200 l metallic drum	-	Brown liquid with oil odor
L09-17	Radar station	200 l metallic drum	-	Brown liquid with oil odor

Continuation of Table 5.4-1

Number of sample	Location	Type of tank	Presence of the stamp and label	Visual characteristics of the specimen
Graham Bell Island				
L02-04	Aviation camp	200 l iron drum	Stamp МС-8П	Thick light brown liquid with oil odor
L02-05	Aviation camp	200 l iron drum	Label «Жидк яд I-НА»	Thick light brown liquid with oil odor
L02-06	Aviation camp	200 l iron drum	Label «ГТЖ 1-НА»	Thick light brown liquid with oil odor
L02-07	Aviation camp	200 l iron drum	Label «1-НА М-66»	Thick light brown liquid with oil odor
L02-08	Aviation camp	200 l iron drum	-	Thick light brown liquid with oil odor
L02-09	Aviation camp	200 l iron drum	-	Thick light brown liquid with oil odor
L03-10	Landing strip	200 l iron drum	-	Thick light brown liquid with oil odor
L03-11	Landing strip	200 l iron drum	-	Thick light brown liquid with oil odor

Figure 5.4-1 Collection of a technical liquid sample from a radar transformer at site 9 (radar station), Alexandra Island

Figure 5.4-2 Marking of the radar components, from which a technical liquid specimen was collected at site 9 (radar station), Alexandra Island

Figure 5.4-3 Marking of the drum, from which a technical liquid specimen was collected at site 9 (radar station), Alexandra Island

Figure 5.4-4 Collection of technical liquid specimens at site 1 (fuel and lubricant storage facility in Severnaya Bay), Alexandra Island

Figure 5.4-5 Collection of technical liquid specimens at site 2 (aviation camp), Graham Bell Island

Figure 5.4-6 Collection of technical liquid specimens at site 3 (landing strip), Graham Bell Island

The results of laboratory control of physico-chemical characteristics of technical liquids (Tables 5.4-2 – 5.4-8) allow to classify specimen **L01-03** as a vehicle motor oil for carbureted engines M-63/10G_1; specimen **L09-12** – as a low pour point hydraulic oil MGE-10A (MG-15-V according to GOST 17479.3-85); specimen **L09-15** – as a transmission oil TSp-10; specimen **L02-04** – as oil MK-8; specimens **01-02, L02-08, L03-09** and **L03-10** – as shock-absorber fluids AZh-12T, MGP-12 and GRZh-12 and specimens **L01-01, L02-07, L03-11, L09-13, L09-14, L09-16** and **L09-17 –** as oil for turboprop engines MN-7,5u.

Specimens **L02-05** and **L02-06** are easily dissolved in water in any proportion and have low flash point and viscosity so they cannot be classified as oils. These may be antifreezes based on ethylene glycol and alcohols or vehicle or aviation fuel additives for removing condensed water.

Table 5.4-2 Conformance of liquid L01-03 to specifications

Vehicle motor oil for carbureted engines M-63/10G$_1$			
Parameter to be determined, unit of measurement	Normative document for testing	Norms for M-63/10G$_1$ according to GOST 10541-78	Actual values of the parameters according to the test results
			L01-03
Density at 20ºC, g/cm³	GOST 3900-85	not more than 0.900	0.900
Viscosity at 100ºC, mm²/s	GOST 33-2000	10.0 ± 0.5	9.95
Flash point in open cup, ºC	GOST 4333-87	not lower than 210	240

Table 5.4-3 Conformance of liquid L09-12 to specifications

Low pour point hydraulic oil MGE-10A(MG-15-V according to GOST 17479.3-85)			
Parameter to be determined, unit of measurement	Normative document for testing	Norms for MGE-10A according to OST 38 01281-82	Actual values of the parameters according to the test results
			L09-12
Appearance	-	Light brown transparent liquid	Light brown transparent liquid
Density at 20ºC, g/cm³	GOST 3900-85	not more than 0.860	0.851
Viscosity at 50ºC, mm²/s	GOST 33-2000	not less than 10.0	13.61
Flash point in open cup, ºC	GOST 4333-87	not lower than 96	124

Table 5.4-4 Conformance of liquid L09-15 to specifications

Transmission oil TSp-10			
Parameter to be determined, unit of measurement	Normative document for testing	Norms for TSp-10 according to GOST 23652-79	Actual values of the parameters according to the test results
			L09-15
Density at 20ºC, g/cm³	GOST 3900-85	not more than 0.915	0.913
Viscosity at 100ºC, mm²/s	GOST 33-2000	not less than 10.0	10.36
Flash point in open cup, ºC	GOST 4333-87	not lower than 128	228

Table 5.4-5 Conformance of liquid L02-04 to specifications

Oil MK-8			
Parameter to be determined, unit of measurement	Normative document for testing	Norms for MK-8 according to GOST 6457-66	Actual values of the parameters according to the test results
			L02-04
Density at 20ºC, g/cm³	GOST 3900-85	not more than 0.885	0.863
Viscosity at 50ºC, mm²/s	GOST 33-2000	not less than 8.3	9.3
Flash point in open cup, ºC	GOST 4333-87	not lower than 140	187

Table 5.4-6 Conformance of liquids L01-02, L02-08, L02-09 and L03-10 to specifications

Shock-absorber fluids AZh-12T, MGP-12, GRZh-12								
Parameter to be determined, unit of measurement	Normative document for testing	Norms for AZh-12T according to GOST 23008-78	Norms for MGP-12 according to Specification 38.301-29-40-97	Norms for GRZh-12 according to Specification 0253-048-05767-924-96	Actual values of the parameters according to the test results			
					L01- 02	L02-08	L02-09	L03- 10
Density at 20ºC, g/cm³	GOST 3900-85	-	not more than 0.917	not more than 0.917	0.900	0.880	0.887	0.895
Viscosity at 100ºC, mm²/s	GOST 33-2000	not less than 3.6	not less than 3.8	not less than 3.9	8.87	5.51	4.13	8.94
Flash point in open cup, ºC	GOST 4333-87	not lower than 165	not lower than 140	not lower than 140	226	210	178	232

Table 5.4-7 Conformance of liquids L01-01, L02-07, L03-11, L09-13, L09-14, L09-16 and L09-17 to specifications

Oil for turboprop engines MN-7,5u								
Parameter to be determined, unit of measurement	Normative document for testing	Norms for MH-7,5y according to Specification 38.101722-85	Actual values of the parameters according to the test results					
			L01-01	L02-07	L03-11	L09-13	L09-14	L09-16	L09-17
Density at 20ºC, g/cm³	GOST 3900-85	not more than 0.900	0.899	0.884	0.893	0.882	0.882	0.893	0.893
Viscosity at 100ºC, mm²/s	GOST 33-2000	not less than 7.5	9.23	9.25	9.03	9.26	9.13	9.33	9.17
Flash point in closed cup, ºC	GOST 4333-87	not lower than 150	227	210	228	213	222	226	228

Table 5.4-8 Physical properties of water-soluble liquids L02-05 и L02-06

Water soluble liquids			
Parameter to be determined, unit of measurement	Normative document for testing	Actual values of the parameters according to the test results	
		L02-05	L02-06
Density at 20ºC, g/cm³	GOST 3900-85	0.940	1.072
Viscosity at 40ºC, mm²/s	GOST 33-2000	2.15	6.41
Flash point in open cup, ºC	GOST 4333-87	<100	121

The consolidated results of the identification of technical liquids by their physico-chemical characteristics are given in Tables 5.4-9 and 5.4-10.

Table 5.4-9 Results of the identification of technical liquids collected on Alexandra Island

Site number	1			9	
Point number	**L01-001**	**L01-002**	**L01-003**	**L09-012**	**L09-013**
Results of identification	vehicle motor oil M-63/10G_1	vehicle motor oil M-8G_1	vehicle motor oil M-63/10G_1 or motor oil for automotive diesel engines M-16IKhP-3 (M-16-$V_{2)}$	low pour point hydraulic oil MGE-10A	vehicle motor oil M-63/10G_1

Site number	9			
Point number	**L09-014**	**L09-015**	**L09-016**	**L09-017**
Results of identification	vehicle motor oil M-63/10G_1	vehicle motor oil M-63/10G_1 or transmission oil TSp-10 motor oil for automotive diesel engines M-16IKhP-3 (M-16-V_2)	vehicle motor oil M-63/10G_1	vehicle motor oil M-63/10G_1

Table 5.4-10 Results of the identification of technical liquids collected on Graham Bell Island

Site number	2			
Point number	L02-004	L02-005	L02-006	L02-007
Results of identification	gas turbine lubricating oil or vehicle motor oil M-63/10G_1 или MK-8	alcohol-containing liquid	supposedly antifreeze based on ethylene glycol	vehicle motor oil M-63/10G_1

Site number	2		3	
Point number	L02-008	L02-009	L03-010	L03-011
Results of identification	MK-8	MK-8	vehicle motor oil M-8G1	vehicle motor oil M-63/10G_1

The results of the determination of PCBs content in technical liquids collected on Alexandra and Graham Bell Islands are given in Tables 5.4-11 and 5.4-12.

Table 5.4-11 Polychlorinated biphenyls content in the specimens of technical liquids collected on Alexandra Island

Site number	1			9	
Point number	L01-01	L01-02	L01-03	L09-012	L09-013
PCB, mkg/kg					
#28	15.61	12.48	10.27	4.66	17.54
#31	<0.5	<0.5	<0.5	<0.5	<0.5
#52	12.42	38.56	55.64	12.40	27.81
#99	4.72	1.66	3.21	2.43	12.54
#101	22.06	17.65	10.28	1.10	8.17
#105	2.24	3.95	5.28	6.76	<0.5
#118	20.68	18.05	7.34	0.46	12.47
#128	<0.5	<0.5	<0.5	31.95	<0.5
#138	21.45	14.74	31.73	30.10	35.28
#153	5.74	50.62	4.27	130.06	9.67
#156	2.49	4.53	<0.5	10.04	1.62
#170	11.45	9.41	3.45	0.96	6.65
#180	24.69	<0.5	19.43	11.61	20.67
#183	<0.5	<0.5	<0.5	75.93	<0.5
#187	33.45	<0.5	10.82	7.43	<0.5
Total PCB	147.54	171.65	161.72	325.88	152.42

Continuation of Table 5.4-11

Site number	9			
Point number	L09-014	L09-015	L09-016	L09-017
PCB, mkg/kg				
#28	13.45	12.87	16.66	9.17
#31	<0.5	<0.5	<0.5	<0.5
#52	20.54	15.37	45.92	40.82
#99	3.78	6.27	10.46	7.16
#101	6.24	21.73	6.13	4.26
#105	<0.5	1.22	<0.5	1.47
#118	2.53	15.13	8.15	5.36
#128	<0.5	<0.5	<0.5	<0.5
#138	15.64	11.37	10.88	8.31
#153	37.82	43.25	77.49	13.59
#156	3.53	<0.5	<0.5	<0.5
#170	1.16	6.75	6.23	2.04
#180	<0.5	11.75	<0.5	28.24
#183	<0.5	<0.5	<0.5	<0.5
#187	25.36	<0.5	<0.5	<0.5
Total PCB	130.05	145.71	167.55	120.42

Table 5.4-12 Polychlorinated biphenyls content in the specimens of technical liquids collected on Graham Bell Island

Site number	2			
Point number	L02-004	L02-005	L02-006	L02-007
PCB, mkg/kg				
#28	13.54	1.57	0.98	15.46
#31	<0.5	<0.5	<0.5	<0.5
#52	52.18	0.63	0.58	13.79
#99	3.57	<0.5	<0.5	10.15
#101	18.49	<0.5	0.24	15.74
#105	0.85	<0.5	<0.5	<0.5
#118	13.24	<0.5	<0.5	12.97
#128	<0.5	<0.5	<0.5	<0.5
#138	28.62	<0.5	0.08	10.38
#153	22.64	<0.5	0.12	37.12
#156	4.58	<0.5	<0.5	<0.5
#170	7.15	<0.5	<0.5	5.42
#180	7.46	<0.5	<0.5	18.64
#183	<0.5	<0.5	<0.5	<0.5
#187	<0.5	<0.5	0.10	<0.5
Total PCB	172.32	2.20	2.12	139.67

Continuation of Table 5.4-12

Site number	2		3	
Point number	L02-008	L02-009	L03-010	L03-011
PCB, mkg/kg				
#28	12.28	11.66	17.25	10.18
#31	<0.5	<0.5	<0.5	<0.5
#52	27.26	67.82	10.02	46.37
#99	<0.5	<0.5	5.89	9.74
#101	10.21	24.83	19.52	5.61
#105	<0.5	0.91	2.46	0.57
#118	7.54	19.16	14.38	4.15
#128	4.51	<0.5	<0.5	<0.5
#138	<0.5	56.14	17.62	20.14
#153	<0.5	2.87	73.94	21.79
#156	<0.5	3.21	2.87	<0.5
#170	3.68	7.44	5.27	2.66
#180	11.98	8.21	<0.5	23.81
#183	<0.5	<0.5	<0.5	<0.5
#187	<0.5	<0.5	<0.5	<0.5
Total PCB	66.24	175.65	169.22	145.02

The results obtained confirm that none of the technical liquids studied is a product based on organochlorine compound; the total content of PCBs in all samples does not exceed several hundreds of micrograms per kilogram of the product. Such a level of the content of organochlorine compounds is allowable for oil and can be explained by the pollution of oil products during their production, canning, transportation and long-term storage. The proportion of PCB congeners in the specimens of the technical liquids studied varies, at the same time the “seven Dutch” congeners (#28, #52, #101, #118, #138, #153, #180) prevail. However, significant differences in their relative contribution to the total content of PCBs imply that the sources of contamination of the liquids studied are many, including the extraction from contacting painted surfaces of the tanks and hoses.

Even an accidental spill of these oil products cannot cause hazardous soil contamination with of organochlorine compounds. It is confirmed the levels of PCB content in soil specimens (maximum – 12 allowable concentrations, 0.24 mg/kg), not reaching the intervention level (1.0 mg/kg) in any soil samples even in the most contaminated with spilled oil products, in which the oil intervention level is multiply exceeded. The analysis of the results has not revealed any similarity of the qualitative PCB composition in contaminated soils with that contained in technical liquids stored in the vicinity of the same site. This shows the presence of different sources of soil contamination both local (release of PCB-containing paint chips from drum and rank surfaces due to corrosion) and associated with PCB intake with atmospheric precipitation and dry precipitation due to long-distance atmospheric transport.

6 CONCLUSION

Reconnaissance survey of the current environmental state of the areas of decommissioned sites of the Russian Federation Ministry of Defense on Hoffman, Graham Bell and Alexandra Islands of Franz Josef Land Archipelago allows us to make an unambiguous conclusion on a significant level soil contamination and degradation at the area under study.

On Alexandra Island, 2.55 sq. km (82 percent) of 3.1 sq. km of the surveyed area man-made degradation are littered and suffer man-made degradation of soil and vegetation cover due to organized and non-organized vehicle traffic. The area of such territories on Hoffman Island is 0.46 sq. km of the surveyed area of 6.1 sq. km (7.5 percent) and on Graham Bell Island – 1 sq. km (71 percent of the surveyed area).

It should be noted most part of the Hoffman Island (more than 90 percent of the area) is covered by a glacier, so it is impossible to determine the actual area of surface contamination.

Most area covered by observation is littered with iron drums with the density from 10 to 30 pieces per hectare. The area affected by this type of contamination amounted to 3.1 sq. km on Alexandra Island, 1.0 sq. km on Hoffman Island, 7.5 sq. km on Graham Bell Island.

The total number of oil and lubricant drums at the territory amounts from 15 to 25 thousand pieces.

On the surveyed area, there are many ruins of technical and general purpose buildings and structures; dumps of metal scrap and domestic and construction waste; abandoned vehicles, radar stations, tanks, cisterns with fuel and lubricants on racks and even aircrafts. The number of these detected and geocoded objects is as follows:

- buildings and structures – 166 (estimated at 50 thousand sq. m);
- vehicles – 83;
- airplanes – 2;
- tanks and cisterns – 600;
- radar stations – 5;
- material and equipment storage yard.- 11;
- garbage and waste dumps – 37 with a total area of 150.4 thousand sq. m.;

In addition, there are from 120 to 150 thousand drums with oil and lubricants in stacks and accumulation at these territories, including:

- on Alexandra Island – 30-35 thousand pieces;
- on Hoffman Island – 20-25 thousand pieces;
- on Graham Bell Island – 75-90 thousand pieces.

It should be taking into account that reconnaissance survey was performed in autumn in the initial phase of snow cover formation, that is why even for the surveyed territories the man-made disturbed areas are significantly larger in size than the above, and with account of non-surveyed areas are multiple larger than those presented in this report

This is also completely true for the number of geocoded objects.

The study of soil quality based on Rospotrebnadzor normative documents SanPiN 2.1.7.1287-03, GN 2.1.7.2041-06 and GN 2.1.7.2042-06 allows to classify the level of contamination at all sites of geoecological testing on Alexandra Island and Hoffman Island as **extra-hazardous** and at the sites on Graham Bell Island:

- as **extra-hazardous** for a part of the territory of the aviation camp;
- as **acceptable** for a part of the territory of the landing strip;

- as **hazardous** for a part of the territory of the air defense base:
- as **hazardous** for a part of the territory of the drum storage facility on the coast.

The assessment according to international standards (Neue Niederlandische Liste. Altlasten Spektrum 3/95) showed that the contamination with oil products at the sites of testing on all the three islands 2-6 times exceeds the intervention level, while the average total content of polycyclic aromatic hydrocarbons 2-8 times exceeds the allowable concentration.

The results of the study of the technical liquids showed that none of the specimens is a product based on organochlorine compound; the total content of PCBs in all samples did not exceed several hundreds of micrograms per kilogram of the product. Such a level of the content of organochlorine compounds is allowable for oil and can be explained by the pollution of oil products during their production, canning, transportation and long-term storage.

Even an accidental spill of these oil products cannot cause hazardous soil contamination with of organochlorine compounds. It is confirmed the levels of PCB content in soil specimens (maximum – 12 allowable concentrations, 0.24 mg/kg), not reaching the intervention level (1.0 mg/kg) in any soil samples even in the most contaminated with spilled oil products. At the same time, the petroleum hydrocarbon content multiply exceeds the intervention level. The analysis of the results has not revealed any similarity of the qualitative PCB composition in contaminated soils with that contained in technical liquids stored in the vicinity of the same site. This shows the presence of different sources of soil contamination both local (release of PCB-containing paint chips from drum and rank surfaces due to corrosion) and associated with PCB intake with atmospheric precipitation and dry precipitation due to long-distance atmospheric transport in the period of their large-scale production.

In view of the above, for developing a project aiming at remediation and rehabilitation of the territories of decommissioned sites of the Russian Federation Ministry of Defense on the archipelago's islands, it is necessary to perform the following

- a series of detailed engineering surveys including topographic geodetic survey of the sites' territories;
- measurement works at the buildings and structures to determine the volume of wastes;
- survey of contaminated areas primarily to specify the configuration and size of zones of oil products leaking, thickness of the oil saturated soil layer, volume and class of toxicity of soils to be cleaned up or disposed;
- other kinds of work regulated by the rules and guidelines for the respective types of engineering surveys;

Taking into consideration the geographical situation of the sites location, work should be carried out in the period of maximum positive temperatures, e.g. in August and the first decade of September

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LIST OF ACRONYMS

AAS A2 – Atomic Absorption Spectrophotometer (AAS) A-02

APC – Approximate Permissible Concentration

DBOFB – Dibromoctafluorobiphenyl

DDT – Dichlorodiphenyltrichloroethane

FJL – Franz Josef Land

GIS – Geographic Information System

IR – Infrared

MPC – Maximum Permissible Concentration

PAH – Polycyclic Aromatic Hydrocarbons

PC – Permissible Concentration

PCB – Polychlorinated Biphenyls

PND F – Federal Environmental Protection Normative Documents

POP – persistent organic pollutants

RD – Regulatory Documents

SanPiN – Sanitary Regulations and Standards

SPA – Scientific Production Association

TBA – tetrabutylammonium

TCN – naphthalene tetrachloride

VAH – Volatile Aromatic Hydrocarbons

VIP-2M – Vibration Hydrometer VIP-2M

Zc – Total Soil Pollution Index

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THE COPIES OF THE LICENCE DOCUMENTS OF SUBCONTRACTORS

ЛИЦЕНЗИЯ

Регистрационный номер **Р / 2006 / 0049 / 100 / Л**

от “ 03 ” июля **2006 года**

ФЕДЕРАЛЬНАЯ СЛУЖБА ПО ГИДРОМЕТЕОРОЛОГИИ И МОНИТОРИНГУ ОКРУЖАЮЩЕЙ СРЕДЫ

разрешает осуществление вида деятельности

«Деятельность в области гидрометеорологии и смежных с ней областях»

Лицензия предоставлена

Обществу с ограниченной ответственностью «И.К.М. ИНЖИНИРИНГ» (ООО «И.К.М. ИНЖИНИРИНГ»)

198099, г. Санкт-Петербург, ул. Калинина, д.13
ОГРН 1057810285554 ИНН / КПП 7805370173 / 780501001

Адреса мест осуществления деятельности: Северо-Западный федеральный округ Российской Федерации, акватории Балтийского, Белого, Баренцева, Карского и Каспийского морей.

Лицензионные требования и условия
(продолжение на обороте)

Срок действия лицензии до “ 03 ” июля **20 11 года**

Федеральная служба по гидрометеорологии и мониторингу окружающей среды (Росгидромет) ОГРН 1037739553192

Руководитель Росгидромета А.И. Бедрицкий

М.П.

Лицензию получил по доверенности от 04.07.2006 N°14 — Мельников С.А 05.07.06г.

1690111 *

ФЕДЕРАЛЬНАЯ СЛУЖБА ПО ГИДРОМЕТЕОРОЛОГИИ И МОНИТОРИНГУ ОКРУЖАЮЩЕЙ СРЕДЫ

Лицензионные требования и условия:

1. Лицензия распространяется на деятельность в области гидрометеорологии и смежных с ней областях, включающую в себя:

- определение метеорологических и гидрологических характеристик окружающей среды;
- определение уровня загрязнения окружающей среды (атмосферного воздуха, почв, поверхностных вод и морской среды);
- подготовку и предоставление потребителям аналитической и расчетной информации о состоянии окружающей среды, о ее загрязнении;
- формирование и ведение банков данных в области гидрометеорологии и смежных с ней областях.

2. Выполнение требований международных договоров, законодательства Российской Федерации, государственных стандартов в области гидрометеорологии и смежных с ней областях.

3. Наличие в штате постоянных работников, имеющих профессиональное образование и стаж работы в области гидрометеорологии и смежных с ней областях не менее 3 лет.

4. Повышение квалификации работников не реже 1 раза в 5 лет.

5. Наличие приборов и оборудования, необходимых для выполнения работ в области гидрометеорологии и смежных с ней областях, включающих в себя работы по п.1 лицензионных требований и условий.

6. Наличие выданного в установленном порядке аттестата аккредитации на проведение наблюдений (в том числе путем отбора и последующего анализа проб) за изменением количественных характеристик физических, химических и биологических процессов, происходящих в окружающей природной среде, и определение уровней ее загрязнения.

7. Передача в установленные сроки в ближайший радиометеорологический центр Российской Федерации оперативных данных, полученных в результате наблюдения, а также экстренной информации о замеченном нефтяном загрязнении морской среды.

8. Незамедлительная передача в Северо-Западное межрегиональное территориальное управление по гидрометеорологии и мониторингу окружающей среды Федеральной службы по гидрометеорологии и мониторингу окружающей среды информации о состоянии окружающей природной среды, ее загрязнении, чрезвычайных ситуациях техногенного характера, которые оказали, оказывают или могут оказать негативное воздействие на окружающую природную среду.

9. Передача информации в области гидрометеорологии и в смежных с ней областях в Единый государственный фонд данных о состоянии окружающей природной среды, ее загрязнении через Северо-Западное межрегиональное территориальное управление по гидрометеорологии и мониторингу окружающей среды Федеральной службы по гидрометеорологии и мониторингу окружающей среды.

Изготовлено ООО П*Т*ГРАФ, г. Москва, зак. № 6129, 2004 год, уровень Б, лицензия Министерства финансов РФ, (095) 332-02-02 (многоканальный), факс (095) 332-64-89

ФЕДЕРАЛЬНОЕ АГЕНТСТВО
ПО ТЕХНИЧЕСКОМУ РЕГУЛИРОВАНИЮ И МЕТРОЛОГИИ

СИСТЕМА АККРЕДИТАЦИИ АНАЛИТИЧЕСКИХ ЛАБОРАТОРИЙ (ЦЕНТРОВ)

АТТЕСТАТ

АККРЕДИТАЦИИ АНАЛИТИЧЕСКОЙ ЛАБОРАТОРИИ (ЦЕНТРА)

Действителен до
"13" мая 2008 г.

Федеральное агентство по техническому регулированию и метрологии удостоверяет, что Испытательная лаборатория "Маринтест"
ООО "И.К.М. Инжиниринг"
198099, г.Санкт-Петербург, ул.Калинина, д.13

соответствует требованиям Системы аккредитации аналитических лабораторий (центров), а также требованиям ГОСТ Р ИСО/МЭК 17025, аккредитован(а) на техническую компетентность и независимость и зарегистрирован(а) в Государственном реестре под № РОСС RU.0001.513066

Область аккредитации приведена в приложении, являющемся неотъемлемой частью настоящего аттестата.

Зам. руководителя Федерального агентства по техническому регулированию и метрологии В.КРУТИКОВ

13 мая 2005 г.

FEDERAL AGENCY ON TECHNICAL
REGULATING AND METROLOGY

ANALYTICAL LABORATORIES ACCREDITATION SYSTEM

CERTIFICATE

OF ANALYTICAL LABORATORY (CENTER) ACCREDITATION

Valid to

" 13" May 2008

Federal agency on tecnhical regulation and metrology certifies, that the Testing Laboratory "Marintest" of the JSC "I.K.M. Engineering" tw.St,-Petersburg

is conformed to reguirements of the Analytical Laboratories Accreditation System, GOST R ISO/IEC 17025, accredited for the technical competence and independence and recorded to the State Register under № РОСС RU.0001.513066

The scope of laboratory (center) accreditation is described in appendix.

Deputy Head of
Federal agency on
technical regulating and metrology V.KRUTIKOV

" 13" 2005

ЛИЦЕНЗИЯ

Б 420540

Регистрационный номер Р/2002/0064/100/Л **от «**19**»** августа **199** 2002**г.**

ФЕДЕРАЛЬНАЯ СЛУЖБА РОССИИ ПО ГИДРОМЕТЕОРОЛОГИИ И МОНИТОРИНГУ ОКРУЖАЮЩЕЙ СРЕДЫ

(наименование органа, выдавшего лицензию)

разрешает осуществление вида деятельности

(вид деятельности)

"Деятельность в области гидрометеорологии и в смежных с ней областях"

Лицензия выдана Государственному учреждению

(для юридических лиц — наименование и юридический адрес предприятия, организации, учреждения, получившего лицензию;

"Научно-производственное объединение "Тайфун"

249038, Калужская обл., г. Обнинск, пр. Ленина, д.82

для физических лиц — фамилия, имя, отчество,

ИНН 4025008866

паспортные данные (серия, номер, кем и когда выдан), место жительства)

Условия осуществления данного вида деятельности (продолжение на обороте)

Срок действия лицензии до 19 августа 2007 года

Руководитель Росгидромета

М. П. **Подпись** А.И.Бедрицкий

(Ф. И. О.)

Лицензия продлена до « **»** **199** **г.**

М. П. **Подпись** (Ф. И. О.)

Сведения о регистрации лицензии на территориях субъектов Российской Федерации

(наименование органа, №, дата)

М. П. **Подпись** (Ф. И. О.)

Лицензионные требования и условия:

1. Лицензия распространяется на деятельность в области гидрометеорологии и в смежных с ней областях, включающую в себя:

- определение метеорологических, климатических, аэрологических, гидрологических, океанологических, гелиогеофизических, агрометеорологических характеристик окружающей природной среды;
- определение уровня загрязнения (включая радиоактивное) окружающей природной среды (атмосферного воздуха, почв, поверхностных вод и морской среды, в том числе по гидробиологическим показателям);
- подготовку и предоставление потребителям прогностической, аналитической и расчетной информации о загрязнении (включая радиоактивное) окружающей природной среды;
- формирование и ведение банков данных в области гидрометеорологии и в смежных с ней областях.

2. Выполнение требований международных договоров, законодательства Российской Федерации, государственных стандартов в области гидрометеорологии и в смежных с ней областях.

3. Наличие в штате постоянных работников, имеющих профессиональное образование и стаж работы в области гидрометеорологии и в смежных с ней областях не менее 3 лет.

4. Повышение квалификации работников не реже 1 раза в 5 лет.

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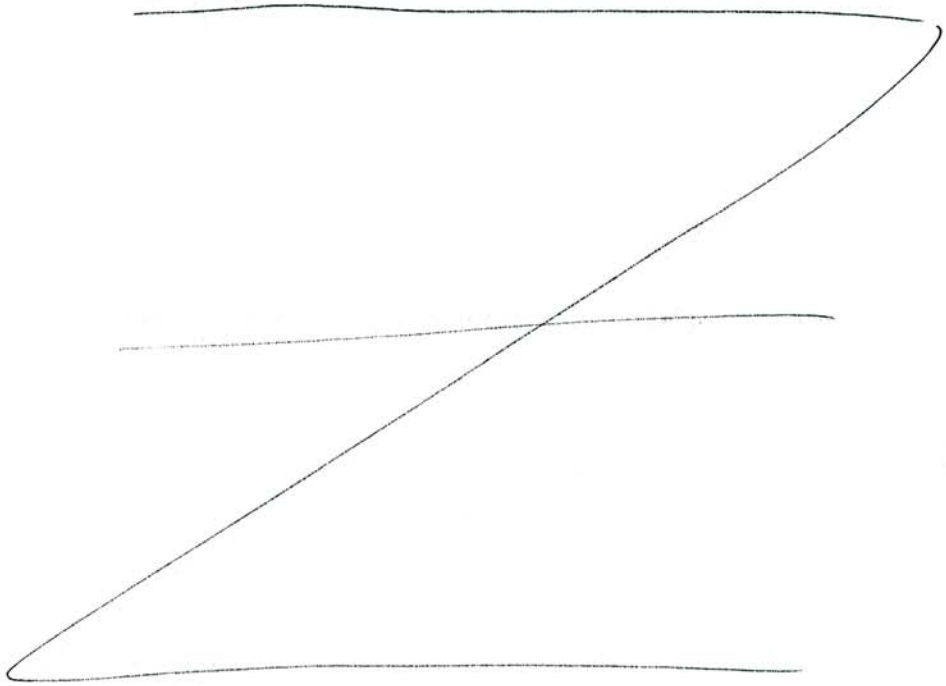
6. Наличие у лицензиата выданного в установленном порядке аттестата аккредитации на проведение наблюдений (в том числе путем отбора и последующего анализа проб) за изменением количественных характеристик физических, химических и биологических процессов, происходящих в окружающей природной среде, и определение уровней ее загрязнения (включая радиоактивное).

7. Передача информации в области гидрометеорологии и в смежных с ней областях в Единый государственный фонд данных о состоянии окружающей природной среды, ее загрязнении.



ФЕДЕРАЛЬНОЕ АГЕНТСТВО ПО ТЕХНИЧЕСКОМУ РЕГУЛИРОВАНИЮ И МЕТРОЛОГИИ

№ 000051

АТТЕСТАТ АККРЕДИТАЦИИ ИСПЫТАТЕЛЬНОЙ ЛАБОРАТОРИИ (ЦЕНТРА) В СИСТЕМЕ АККРЕДИТАЦИИ АНАЛИТИЧЕСКИХ ЛАБОРАТОРИЙ (ЦЕНТРОВ)

№ РОСС RU.0001.510523

Действителен до «03» октября 2011 г.

НАСТОЯЩИЙ АТТЕСТАТ ВЫДАН Северо-Западному филиалу ГУ "Научно-производственное объединение "Тайфун"

наименование юридического лица с указанием организационно-правовой формы

199397, г.Санкт-Петербург, ул.Беринга, д.38

адрес юридического лица

И УДОСТОВЕРЯЕТ, ЧТО Химико-аналитический испытательный центр "АРЛЭКС"

наименование ИЛ (ИЦ)

199397, г.Санкт-Петербург, ул.Беринга, д.38

адрес ИЛ (ИЦ)

СООТВЕТСТВУЕТ ТРЕБОВАНИЯМ ГОСТ Р ИСО/МЭК 17025 - 2000 (МЕЖДУНАРОДНОГО СТАНДАРТА ИСО/МЭК 17025: 1999),

АККРЕДИТОВАН(А) В СИСТЕМЕ АККРЕДИТАЦИИ АНАЛИТИЧЕСКИХ ЛАБОРАТОРИЙ (ЦЕНТРОВ)

НА техническую компетентность и независимость

(техническую компетентность или техническую компетентность и независимость)

ДЛЯ ПРОВЕДЕНИЯ РАБОТ ПО ИСПЫТАНИЯМ В СООТВЕТСТВИИ С ОБЛАСТЬЮ АККРЕДИТАЦИИ.
ОБЛАСТЬ АККРЕДИТАЦИИ ОПРЕДЕЛЕНА ПРИЛОЖЕНИЕМ К НАСТОЯЩЕМУ АТТЕСТАТУ И ЯВЛЯЕТСЯ ЕГО НЕОТЪЕМЛЕМОЙ ЧАСТЬЮ.

Руководитель (заместитель Руководителя) _____ Г.И.Эльнин

подпись инициалы, фамилия

М.П.

Зарегистрирован в Едином реестре

«23» октября 2006 г.