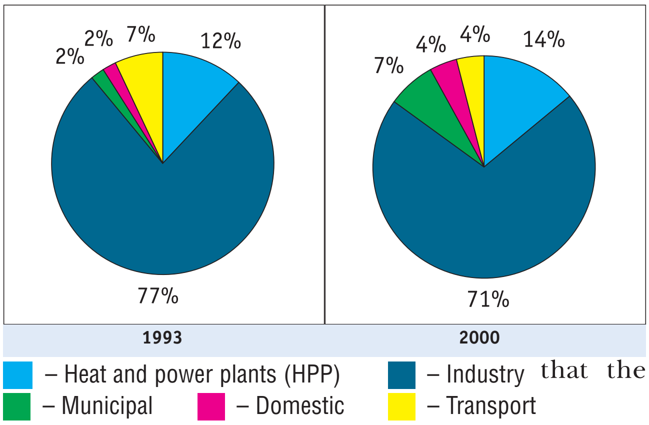


Figure 4.67. Contribution of different types of activities in the Lovozero area to dioxin emissions through the combustion of organic fuel.

that the contribution from the municipal sector, particularly from local boilers used for non-centralized heating, has significantly increased in recent years. Although still much less than emissions from industrial enterprises, the three-fold growth in dioxin emissions from municipal sources within seven years (from 42.23 mg TEQ in 1993 to 122 mg TEQ in 2000) is a matter of concern.

4.4.3. Nenets Autonomous Okrug (NAO)

4.4.3.1. General description

The main focus of the PTS source inventory within the NAO is data acquired from the city of Nar'yan-Mar, which is the most significant pollution source in the vicinity of the indigenous settlement of Nelmin-Nos.

Construction of various industrial facilities, and roads, as well as extraction and transportation of minerals (primarily oil and gas), have had a considerable impact on the environment in the NAO. A total of eighty-one deposits of petroleum hydrocarbons have been found in the territory of the NAO, of which seventy-eight are on land and three on the Barents Sea shelf. Among the terrestrial deposits, sixty-six are of oil; six of oil and gas condensate; four of gas condensate; one of gas; and one of gas and oil. The city of Nar'yan-Mar and the settlement of Harjaga could both be considered as regional pollution sources.

Growth of activities associated with the development of oil and gas deposits has been followed by an increase in anthropogenic pollution impacts on the environment, including:

- air pollution due to emissions of hazardous substances (including that from associated gas flaring);
- pollution of surface and ground waters through discharges of polluting substances;
- extraction, together with oil, of associated highly mineralized production water;
- changes in the landscape (excavations, extraction of materials for construction of the oil and gas production infrastructure, building, cargo transportation, construction of roads, etc.), deforestation, soil pollution by petroleum products, etc.;
- landfill disposal of drilling waste;
- oil spill emergencies.

In 2002, air emissions from stationary and mobile pollution sources amounted to 35.1 kt (in 2001 the total amount of emissions was 36.6 kt), including 1.47 kt of dust and 36.6 kt of gaseous and liquid pollutants. Gas emissions associated with oil extraction are very high, and methods of utilising the gas have not yet been developed in NAO.

In 2002, 24.5 kt of pollutants were emitted to the atmosphere by stationary pollution sources. The basic components of these air emissions were: ashes (720 t); soot (720 t); SO_2 (3750 t); CO (12200 t); NO_2 (4600 t) and hydrocarbons (2400 t). Although these pollutants cannot be considered as PTS, their emissions are a measure of total environmental stress in the region. The major polluters of the atmosphere are the energy producing companies: 'Total RRR', JSC 'Varandeygaz';

Table 4.25. Industrial emissions from major enterprises in the NAO in 2002, tonnes.

Enterprise	Total	Dust	SO_2	CO	NO_2	Hydro-carbons	Specific contaminants
'Total RRR' (Survey, exploitation, development)	4472.7	0.0	2126.8	1154.8	533.6	158.5	H_2S 1.1; methane 2.7
JSC 'Varandeygaz'	2597.7	210.5	50.2	1735.2	183.2	218.7	Acrolein 2.1
JSC 'Arcticneft'	2576.2	101.2	66.6	1718.1	246.3	203.2	Acrolein 2.4; vapours of benzene 33.9; V_2O_5 1.2; methane 23.2
Company 'Polyarnoye Siyanie' Ltd	1868.0	8.3	10.7	1350.3	304.0	193.7	Acrolein 1.1.
JSC 'Pechoraneft'	1686.2	170.1	5.0	14.8	55.8	1440.0	Acrolein 0.6
'Lukoil-Komi' Ltd	1528.2	59.7	0.0	715.6	332.7	311.1	Xylol 1.3; toluene 1.1; acetone 0.16; butanol 0.23; methane 104.7
Municipal service of the Nenets district	1210.8	324.5	297.6	160.3	379.7	48.7	
State industrial combine 'AMNGRE'	1018.4	7.6	18.2	7743.9	203.5	26.3	Acrolein 2.3; methane 16.5
JSC 'Severgeoldobycha'	957.0	33.2	73.4	178.2	586.0	78.3	Acrolein 7.7
Nar'yan-Mar heat and power plant	617.6	10.0	20.1	315.8	244.4	24.7	Acrolein 2.4; methane 0.3

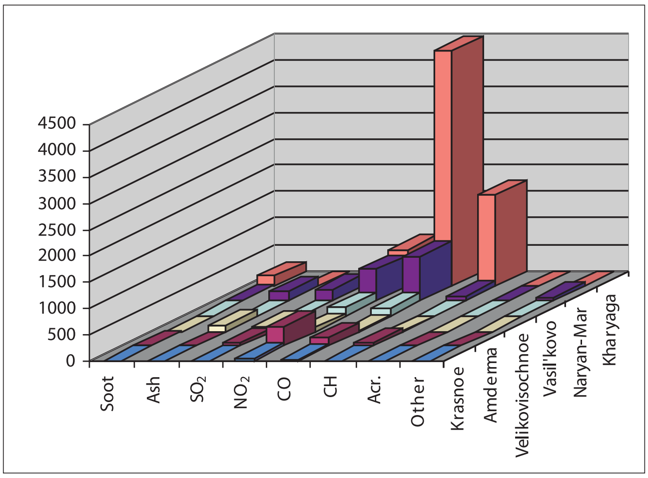


Figure 4.68. Air emissions in major NAO settlements in 1999, tonnes.

JSC 'Arcticneft'; 'Kompaniya Polyarnoye Siyanie' Ltd; JSC 'Pechoraneft'; and 'Lukoil-Komi' Ltd. (Table 4.25). Air emissions from the largest NAO settlements are shown in Figure 4.68.

Official statistics do not document any significant pollution sources in the lower part of the Pechora basin, although wastewater discharges have increased 1.7-fold since 1998, mostly due to water use in oil and gas production and by municipal services.

Nar'yan-Mar port is one of pollution sources and is located on the right bank of a narrow channel, the Gorodetsky Shar, which joins the Great Pechora river 1.5 km upstream of its mouth and 110 km from the Bolvansky cape. The port has no storage tanks and, therefore, wastewater is discharged directly into the Pechora river without treatment.

Levels of pollutants in the Pechora delta tend to be elevated. Contamination is connected, not only with the local activities, but also, to a large extent, with pollution due to wastewater discharges from enterprises located in the Pechora basin involved in gas and oil production (i.e, polluting substances transported with the Pechora flow). However, based on the data and information obtained from project activities concerned with the assessment of riverine pollution fluxes, it may be possible that there are also considerable sources of PTS located between the settlements of Oksino and Andeg (an area which includes Nar'yan-Mar and its suburbs) which contribute to PTS fluxes in the river flow.

The current system of handling solid household wastes in Nar'yan-Mar consists of the collection of waste in containers, cesspools, and auto-dumpers, followed by their transportation to landfill using specialized and other motor transport. In addition, household wastewater is also transported to landfills, since most existing housing is not connected to sewer systems, and the capacity of older treatment facilities is insufficient. However, due to the recently commissioned new treatment facilities, and work to increase the capacity of older sites, the volume of household wastewater entering landfills is decreasing every year. In other NAO settlements, solid and liquid household waste is removed not only to authorized sites, but also, to a large extent, to illegal landfills.

The system of solid household waste collection does not allow the separation of hazardous wastes (e.g., those containing mercury batteries, plastics, etc.) and dumping of such wastes at landfill sites results in environmental contamination by dangerous toxic substances, including dioxins, especially if fires occur. Communal solid waste, together with hazardous waste in landfills is also subjected to the effect of precipitation which washes pollutants down into the soil profile, and subsequently leads to their transport with ground waters. The situation is aggravated by a lack of landfill sites equipped with environmental facilities, and the low capacity of waste treatment facilities in Nar'yan-Mar and other NAO settlements. Existing landfills do not meet environmental or sanitary requirements as:

- they lack sanitary protection zones,
- they lack rainwater filtrate removal and treatment systems;
- they lack waterproof screens.

The most hazardous and widespread waste products are luminescent lamps containing mercury (2.49 t in 2000), obsolete accumulators (4.1 t), used motor oil (119.3 t), drilling sludge (7908 t) and oil-slime (329.2 t).

There are no facilities specifically designed for the processing or incineration of solid communal waste in NAO, and only a small amount of solid communal waste is incinerated at industrial sites, generally those involved in oil and gas development activities.

Processing of medical waste, rubber waste products, and ash-and-slag wastes from boiler-houses, has also not been developed in NAO. The medical institutions of the city of Nar'yan-Mar generated 16.8 t of waste products that were transported to the municipal landfill site in 2001.

4.4.3.2. Inventory of PTS pollution sources

Pesticides

According to information obtained from the Department of Agriculture and Foodstuffs of the NAO Administration, no chlorinated pesticides, insecticides, disinfectants, etc., have been used in the last ten years in the Pechora river flood-plain by any agro-industrial enterprises or related organizations. Hexachlorobenzene (HCB) has not been used as a disinfectant.

Industrial chemical compounds

According to information received, no enterprises exist in Nar'yan-Mar or in territories adjoining the settlement of Nelmin-Nos that could represent a potential

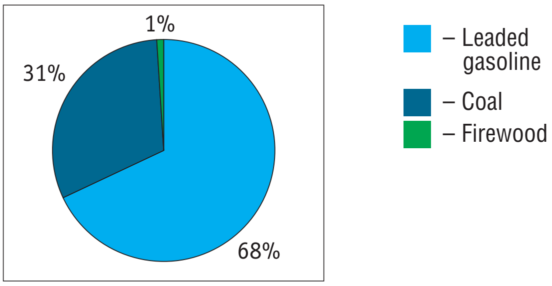


Figure 4.69. Lead emissions from organic fuel combustion in the Nelmin-Nos area.

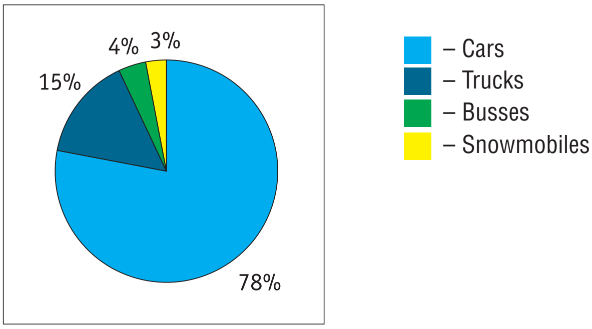
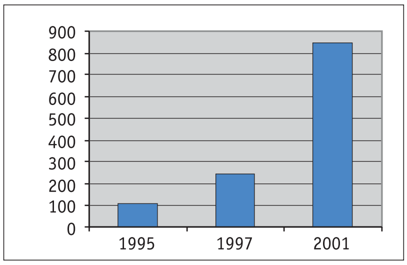


Figure 4.70. Lead emissions resulting from different means of transportation in the Nelmin-Nos area.

Figure 4.71. Lead emissions from the combustion of leaded gasoline in the Nelmin-Nos area, kg.



source of polychlorinated biphenyls (PCBs), originating from equipment containing PCBs, or brominated flame retardants.

4.4.3.3. PTS mobilization from combustion of fossil fuels

Official statistical data on fossil fuel consumption in the NAO was used to calculate PTS emissions. The fuel amount consumed in the NAO within the Nelmin-Nos area was estimated based on the assumption that the population of this area (including Naryan-Mar, the settlement of Krasny, and Nelmin-Nos itself), comprises 65% of the total NAO population. Account was also taken of the fact that that most of the population in the area (27000 out of 29300) live in Nar'yan-Mar.

Lead

In the Nelmin-Nos area, lead emissions from organic fuel combustion arise mainly from leaded gasoline (Figure 4.69) used by vehicles with internal combustion engines (Figure 4.70). However, the total annual emissions of lead from fossil fuel combustion are very low.

It should be noted that, due to a significant growth in the number of motor vehicles in the area in recent years, an increase in lead emissions has been documented, despite the introduction of unleaded gasoline (Figure 4.71).

Mercury

Mercury mobilization from the combustion of fossil fuels in the Nelmin-Nos area is rather small. For example, in 1997 it did not exceed 1 kg. Such low levels of mobilization can be explained by the widespread use of natural gas by major consumers, in particular the Nar'yan-Mar heat and power plant and municipal boilers.

Polyaromatic hydrocarbons (PAHs)

Data on PAH emissions from the combustion of various kinds of hydrocarbon fuels in the Nelmin-Nos area, including Nar'yan-Mar, are presented in Figure 4.72. A major contribution to total PAH emissions is made by the gasoline-fueled motor vehicles. It is notable that the role of gasoline in total PAH emissions has increased drastically in recent years, due to a significant growth in the number of cars in the area, particularly in Nar'yan-Mar. Before that, diesel fuel had played a dominant role (Figure 4.73).

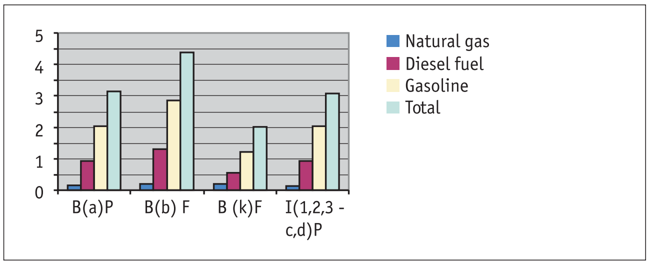


Figure 4.72. PAH (benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]flouranthene, and indeno[1,2,3-c,d]pyrene) emissions from the combustion of hydrocarbon fuel types in the Nelmin-Nos area in 2001, kg.

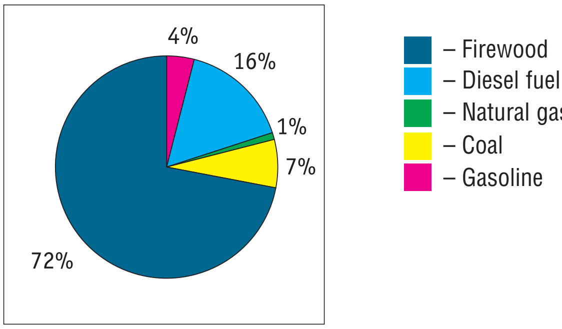


Figure 4.73. Contribution of different types of organic fuel to benzo[a]pyrene emissions in the NAO in 1995.

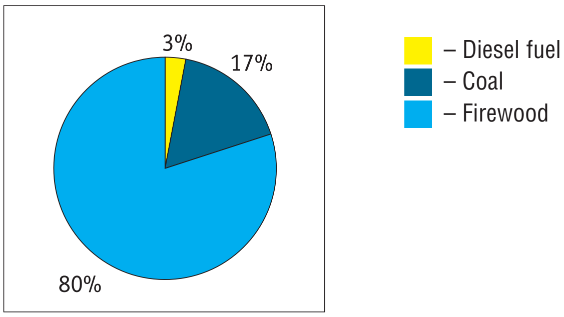


Figure 4.74. Contributions to total dioxin emissions from combustion of major organic fuel types in the NAO in 1997.

The contribution of coal to PAH emissions in this area is much lower than in other project pilot study areas, since petroleum hydrocarbon fuel types dominate in this oil and gas producing region. However, the largest contribution to PAHs comes from firewood. As firewood is mainly used for domestic heating, this fact is of particularly concern in relation to possible impacts on human health.

Dioxins

According to expert estimates, total dioxin emissions in the inventory area in 1997 were 687.15 mg TEQ. Contributions of different types of organic fuel to total dioxin emissions are shown in Figure 4.74. Fuels such as natural gas, gasoline, and kerosine contribute considerably less than 1% of total emissions.

Attention should be paid to the fact that a major contribution to total dioxin emissions arises from the use of firewood for heating and other domestic needs. As these emissions arise from the burning of organic fuels in the home, and particularly from open fires commonly used by indigenous peoples in their traditional dwellings, this fact is a matter of particular concern in the context of possible exposures to humans and related health implications.

4.4.4. Taimyr Autonomous Okrug (TAO)

4.4.4.1. General description

In the TAO, the inventory of local sources covered the vast territory around the city of Norilsk, which forms the main basis for the economy of the entire TAO. Norilsk has a dominating influence on the environment of adjacent territories, including the areas of the settlements Dudinka and Khatanga, which are the centers of residence for the indigenous population.

The TAO population, including the Norilsk Industrial Area (NIA), is 288600 (based on 1996 data). The population of the NIA itself is 44100. The population of the town of Khatanga is about 5000, and that of the town of Dudinka and settlement Dikson more than 31300. Most of the urban population resides in the city of Norilsk, however, this city is formally outside of the TAO jurisdiction, and administered as a subsidiary of the Krasnoyarsk Krai.

Annual industrial air emissions from enterprises located in the TAO territory amount to more than 2 million tonnes of pollutants. Thirty-nine different pollutants are monitored in these emissions. The bulk of the emissions comprise sulphur dioxide, followed by sulphuric acid, inorganic dust, carbon monoxide, and nitrogen dioxide. Emissions from stationary sources are dominant and amount to about 99% of total industrial emissions in the region. This equates to two-thirds of emissions in the Krasnoyarsk Krai, and 14% of all industrial emissions in the Russian Federation. 2309 stationary industrial emission sources have been registered in the TAO territory, of which only 318 are equipped with gas treatment facilities to reduce emissions.

The Norilsk Industrial Area, the largest copper and nickel producer in the Arctic and the Russian Federation, is located about 60 km from Dudinka, to the east of the river Yenisey, covering an area of about 60 thousand km^2 in the northwestern part of mid-Siberian plateau between longitudes 86–92°E, and latitudes 68-70°N. It is acknowledged as the largest single source of environmental pollutants, not only in the region, but in the whole circumpolar Arctic.

4.4.4.2. Geographical areas of concern

Norilsk Industrial Area (NIA)

The former Norilsk Mining and Metallurgical Combined Plant, now called 'Norilsky Nickel' JSC, is the main polluter in the territory.

In the 1980s, it began operating a number of plants producing elemental sulphur, which through recovery of sulphur (at a maximum recovery of 20%) substantially decreased SO_2 emissions and significantly improved the environment of the region. However, SO_2 is still the main contaminant emitted in the NIA, accounting for 96.7% of total emissions. In addition to SO_2, 'Norilsky Nickel' JSC emits a wide range of contaminants, among which are heavy metals, including those addressed in the project.

Automobiles are acknowledged as an important source of some PTS emissions. In this respect, the NIA is singular because it does not have any extensive railway network for passenger or cargo transport. To compensate for this drawback use of road vehicles is widespread, with associated negative impacts on air quality in residential areas. In winter, when temperature inversions are common, pollution of the lowermost atmospheric layer from vehicle exhausts often exceeds pollution from stationary emission sources.

High levels of sulphur dioxide in air are recorded in the city on about 350 days a year, including 120 to 150 days with levels from 5 to 10 times the Maximum Acceptable Concentration (MAC), and 40 to 60 days with a level exceeding 10 times the MAC.

The total duration of air pollution amounts to around 50% of the year, 80% of this time with a level of under 5 MAC, 15 to 17% of the time with a level from 5 to 10 MAC, and 2 to 4% of the time with levels of 10 MAC or more Due to the prevailing wind directions, the main pollution sources for the city's atmosphere are the copper plant, the nickel plant, and the sinter plant. In spite of protection measures in place, the atmospheric air pollution level in the city is gradually increasing (Table 4.26).

About 20 million tonnes of solid waste are produced annually in the NIA (23.4 million tonnes in 2000). Over the entire period of industrial activities in the area, more than 400 million tonnes of mining and industrial

Table 4.26.
Average concentrations of air pollutants in the city of Norilsk (mg/m³), and their trend (mean annual change based on linear regression) over the period 1996-2000; and total emissions (thousand tonnes) from the combined smelter, 'Norilsky Nickel' JSC during the same period.

Pollutants	1996	1997	1998	1999	2000	Trend
SO_2	0.22	0.17	0.13	0.21	0.21	0.002
NO_x	0.03	0.02	0.04	0.05	0.05	0.007
NO	0.04	0.03	0.06	0.07	0.08	0.012
Phenol	0.002	0.003	0.002	0.004	0.006	0.001
Formaldehyde	0.022	0.017	0.006	0.011	0.040	0.003
Cl_2	0.01	0.03	0.00	0.00	0.00	-0.005
Total emissions from 'Norilsky Nickel' JSC	2155	2185	2139	2171	2145	

wastes have been accumulated, whilst no more than 5% of the existing waste have been recycled. The waste composition is 99% mining and industrial waste (of which 94% are bearing strata and overburden), and 1% waste from domestic consumption.

About 2400 hectares are occupied by rock dumps. In addition, 1500 hectares have been damaged by stripping. Tailing dumps occupy a further 1500 hectares. About 10 million tonnes of toxic waste containing more than 50 different components, and more than a million tonnes of slag are stockpiled in the territory each year. Almost no waste-storage sites conform fully to current legal and regulatory requirements.

The NIA drainage system falls mainly within the basin of lake Piasino. The bulk of 'Norilsky Nickel' JSC's wastewater is discharged into this hydrological system. The biggest water course in the region is the river Norilskaya, which connects the lakes Melkoye and Piasino. Secondary rivers, namely the Shchuchya, Kupets, Yergalakh, Ambarnaya, Daldykan, and others, are tributaries of the Norilskaya or flow directly into the lake Piasino, which is the biggest lake in the region (Figure 4.75).

Dudinka area

The town of Dudinka is located on the right bank of the river Yenisey at its confluence with the Dudinka river, 433 km upstream from the mouth of the Yenisey. Dudinka port works practically all year round and specializes in the offloading of imported cargo (petroleum products, food stuffs, and construction materials for the Norilsk plant and for the town of Dudinka), and the export of copper-nickel concentrate for the various mining and smelting companies and enterprises. The port is equipped with its own transport infrastructure, a large oil depot, and the facilities necessary for handling of contaminated bilge waters and household wastewater. In total, the port (based on data for the early-1990s) receives about 7600 t of waste products from vessels, including about 300 t of oil-containing waste.

Pollution of water around the port occurs a result of wastewater discharges from both the port, and from entities located nearby. More than two million m³ of wastewater is discharged to the waters around the port each year. A proportion of bilge and domestic wastewater from shipping is released directly into the waters of the port. Some of the polluting heavy metals (copper, nickel, cobalt, etc.) enter the water as a result of the wash-out from bulk copper-nickel concentrates.

Air operations are located in the Dudinsky area, and construction and geological prospecting organizations also operate from the city. The town infrastructure is maintained by the bodies responsible for municipal housing and communal services. These, the road department, trade organizations, and a smoke-house

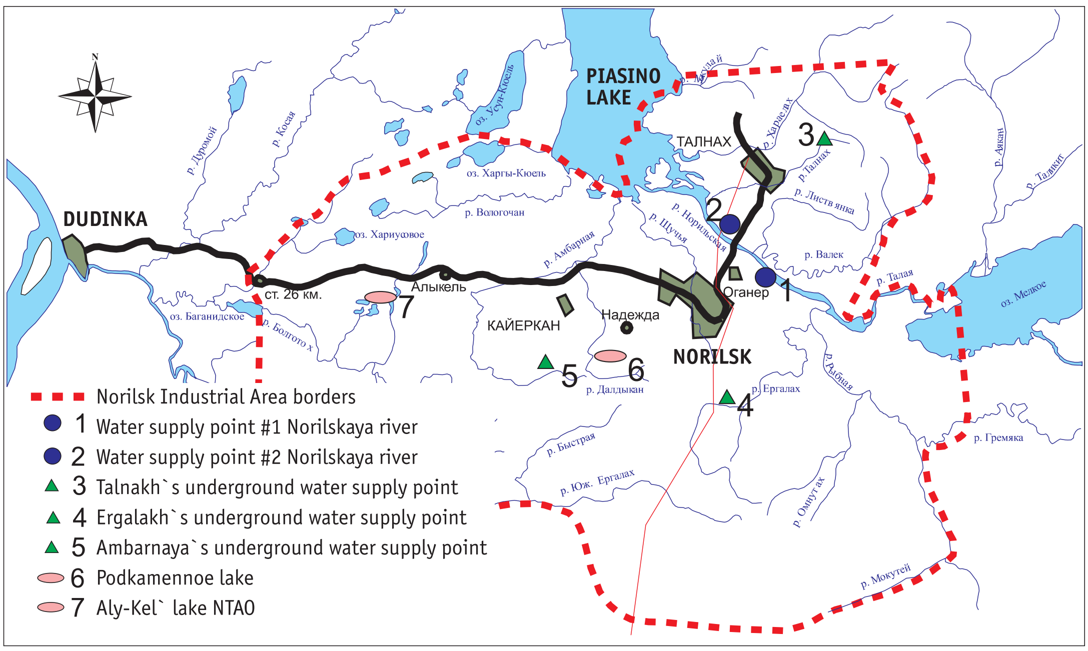


Figure 4.75.
The drainage network of the Norilsk Industrial Area.

are not formally considered as PTS sources under the inventory of local sources, but as a whole exert a very insignificant influence on the environmental state of the adjoining territories, when compared to the neighboring Norilsk smelter.

Khatanga area

The Khatanga settlement is located on the left bank of the river Khatanga, 110 km from its mouth. The population of the settlement numbers 5000. There are relatively few large enterprises based in the settlement. Those present include an aviation enterprise connected with the local airport, a sea cargo port, a fish-processing factory, housing and municipal services, three oil depots, a base for polar expeditions, and a number of state agricultural producers and co-operative enterprises, etc.

The settlement municipal services share a water supply and sewage network with the industrial enterprises, and water is taken from the river Khatanga upstream of the settlement. Wastewater enters a main settlement collector, and after mechanical treatment, is discharged back into the river Khatanga 1.5 km downstream of the settlement. Water consumption by the settlement and industrial enterprises has reduced over the last few years. According to figures from the Sea Inspectorate of the Krasnoyarsk Krai, wastewater discharge into the river Khatanga from the settlement collector in 1994 was about 1 million m^3. There are no data available, however, on the chemical composition of wastewaters.

Khatanga port, which is located at the left bank of the river Khatanga 112 km upstream from its mouth, operates for three to three-and-a-half months during the summer navigation period. There are 5 berths in the port adapted to serve sea vessels up to 5000 tonnes. Handling operations are carried out along the port road, and also along the road in Kozhevnikova bay. The port has no oil depot of its own, however, there are three depots near the harbour area, belonging to other departments.

The port itself consumes up to 400000 m^3 of water, including 140000 m^3 for industrial needs, and 260000 m^3 for economic and household needs. Wastewater is discharged into the main settlement collector. The total discharge of untreated waters is 6-8 million m^3 per year. The port has the technical capability to collect wastewater from sea-going vessels. After fuel and oil separation, remaining oil and slag are incinerated in boiler-houses and operational waste is transferred to landfill.

The main air pollution sources in the settlement are the eleven departmental boiler-houses utilizing local coal, and the airport facilities, which use diesel fuel. In total, heating the settlement of Khatanga requires about 45–50000 t of coal per year. About 3000 t of suspended substances, more than 500 t of sulphur dioxide, more than 750 t of carbon monoxide and approximately 180 t of nitrogen oxides are emitted into the atmosphere. About 85% of emissions deposit directly onto the area occupied by the settlement, over a radius of 3–3.5 km.

4.4.4.3. Inventory results

Pesticides

According to the TAO Veterinary Medicine Administration (pers. comm., letter no. 144 of 10.04.2003), the district veterinary service regularly used the insecticide dichlorodivinylphosphate (DDVP) against mosquitoes and gadflies in the summer, during the period 1980 to 1991. In total, up to 1270 litres of the insecticide were used on farms in Khatanga, Ust-Yenisey and Dudinka Districts. Currently, no pesticides are used in the TAO for agricultural purposes.

Polychlorinated biphenyls (PCBs)

The PCB inventory carried out in 1999 in the NIA revealed the presence of electric equipment, namely, transformers and capacitors, filled with the dielectric fluids, Sovtol-10, Askarel, and Pyralene. The quantity of these synthetic PCB-containing fluids amounts to 451.5, 145.0, and 10.38 t, respectively (Table 4.27). These figures have not changed since 1999.

Most pieces of equipment containing the above fluids are operative. Among 226 transformers, 222 are in service, three have been decommissioned, and one is held in reserve. Among 643 capacitors, 368 are in service, 246 have been decommissioned, and 29 are held as a reserve stock. Decommissioned equipment contains 5.64 t of Askarel and 0.89 t of

Table 4.27. Inventory of PCB-containing electric equipment located at 'Norilsky Nickel' JSC (data for 1999).

Enterprise	Transformers, pcs.				Capacitors, pcs.				Synthetic PCB-containing transformer oil, tonnes					
		Including				Including						Including		
	Total	In operation	In reserve	Decommissioned	Total	In operation	In reserve	Decommissioned	Total	Brandname	PCB content, %	In operation	In reserve	Decommissioned
'Norilsky Nickel' JSC	226	222	1	3	643	368	29	246	451 145 10	Sovtol-10 Askarel Pyralene	90% N/A N/A	448.32 139.36 9.49	3.14 - -	- 5.64 0.89

Table 4.28. Nomenclature and characteristics of PCB-containing waste at 'Norilsky Nickel' JSC (data for 1999). Wastes were generated for 1996-1999 as a result of the decommissioning of 3 transformers and 246 capacitors.

#	Waste type	Amount of waste, t/year	PCB amount, t/year,		Kind of waste handling (warehousing, landfill disposal, reprocessing, transfer to the third-part organizations)	Notes
			Content in waste, %	Total, t/year		
1	Askarel	5.64	100%	5.64	Warehousing (two imported transformers)	At the plant site
2	Pyralene	0.89	100%	0.89	Warehousing (1 imported transformer)	At the plant site
3	Sovtol-10	N/A			Warehousing (246 capacitors)	Indoors and at the plant site

Pyralene (Table 4.28), and is still located at the plant sites. There have been no documented discharges or incidents of site pollution from transformer oils.

The inventory of PCB discharges has shown that, during the operation and maintenance of transformers, about 10 litres of PCB per annum on average are spilled from each transformer (AMAP, 2000). According to these estimates, transformers used by the Norilsk Mining Plant discharge 3.33 t of PCB per annum. Over the whole operating period (the service life of transformers is assumed to be 25 years), 83.25 t of PCB will have been discharged to the environment.

Dioxins and furans
Within the TAO, unintentional formation of dioxins and furans is related to industrial production and may occur during thermal processes carried out at the metallurgical plants of 'Norilsky Nickel' JSC, which reprocess sulphurous ores in the production of non-ferrous metals. It is very likely that, regardless of the lack of studies to date on the presence of dioxins and furans in environmental emissions from its production lines, the plant may be a source of pollution in connection with these substances.

Other possible sources of these contaminants may include:
- incineration of fossil fuels in the boilers of public utilities in the studied localities;
- vehicles, mainly those running on leaded gasoline;
- sources related to fossil fuel burning for household heating;
- open uncontrolled burning of solid household waste at dumps.

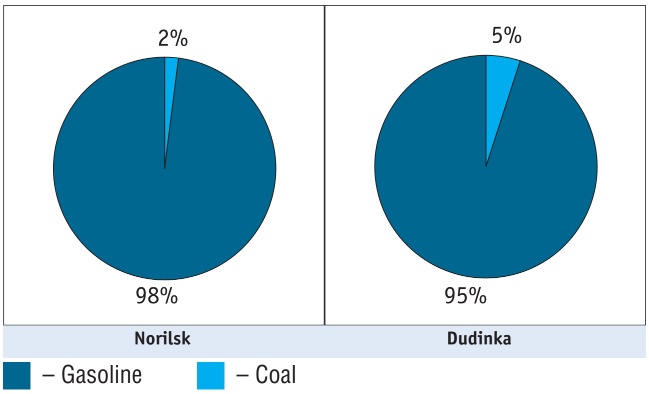


Figure 4.76. Lead mobilization through the combustion of coal and gasoline in the TAO in 1997.

The presence of Cl_2 in the air of Norilsk in previous years (see Table 4.26) could be an indicater of possible dioxin formation in the area, as there is no pulp and paper industry in the TAO territory and no community solid waste incineration plants or production of chlorinated organic products.

Mercury
As stated above, non-ferrous metal production is a significant source in the mobilization of mercury. In 2001, the NIA produced 120000 t of primary nickel and 357000 t of primary copper. According to expert estimates, production of these amounts of non-ferrous metals would be accompanied by the mobilization of 1.7–2.02 t of mercury, emitted to the atmosphere. In addition, 0.65–0.99 t of mercury would have accumulated in captured dust (COWI, 2004).

Lead
According to official statistics, annual emissions of lead in the inventory area vary from 26.5 to 32.8 t.

4.4.4.4. PTS mobilization from combustion of fossil fuels
As in the other pilot areas, estimates of PTS emissions were based on the consumption of different types of organic fuel. It is important to note, that the inventory areas of the TAO, and the NIA in particular, are characterized by high levels of coal consumption, and this essentially determines PTS mobilization associated with fossil fuel combustion.

Lead
Due to high coal consumption, and a decrease in the use of leaded gasoline, lead mobilization from coal dominates, particularly in the NIA (Figure 4.76). It should be noted that the annual amount of lead mobilized through coal combustion in the NIA is higher than lead emissions by the 'Norilsky Nickel' JSC in the production of non-ferrous metals due to lead mobilization from the ores (Figure 4.77). Total lead mobilization through coal combustion in Dudinka and Khatanga comprises about 0.5% of that in the NIA.

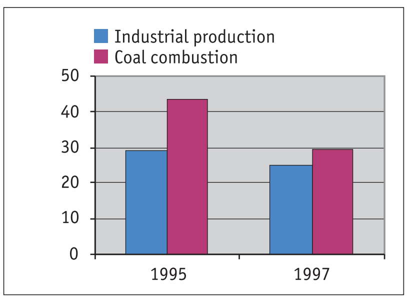


Figure 4.77. Lead emissions in the NIA from industrial production and coal combustion.

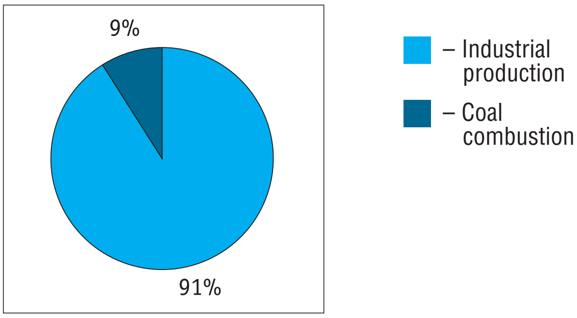


Figure 4.78. Sources of atmospheric emissions of mercury in the Norilsk Industrial Production in 2000.

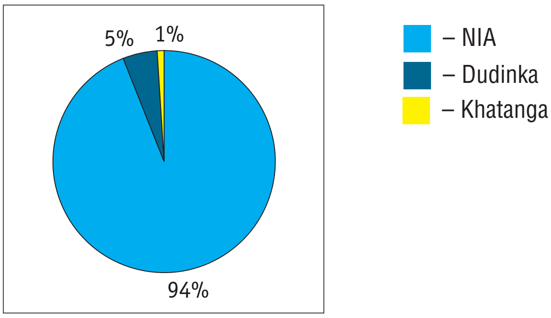


Figure 4.80. Contributions of different source regions to benzo[a]pyrene emissions from the combustion of hydrocarbon fuels in the TAO.

Mercury

Use of natural gas and other types of petroleum hydrocarbon fuels for energy production produces a relatively minor contribution to mercury mobilization. For example, use of natural gas in the NIA, contributes annually about 10g of mercury. A more significant contribution to mercury emissions is made by coal used for heat and power production. As almost 99% of total coal combustion in the TAO occurs in the NIA, and (in addition to the even more substantial emissions from production of non-ferrous metals) coal contributes 10% of the NAI emissions of mercury to the atmosphere (Figure 4.78), the NIA is clearly responsible for the greater part of the mercury contamination from the TAO.

Polyaromatic hydrocarbons (PAHs)

Total PAH emissions to the atmosphere due to the consumption of hydrocarbon fuels in the TAO, including the NIA, are presented in Figure 4.79. For all PAHs, as in the case of benzo[*a*]pyrene (Figure 4.80), the main contribution is made by the NIA. It should be noted that contributions from defense-related activities have not been included in the inventory estimates, since this information was not available to the assessment. Because of this, contributions from areas outside of the NIA, for example Khatanga, may be higher. However, the pre-eminent role of NIA will not change.

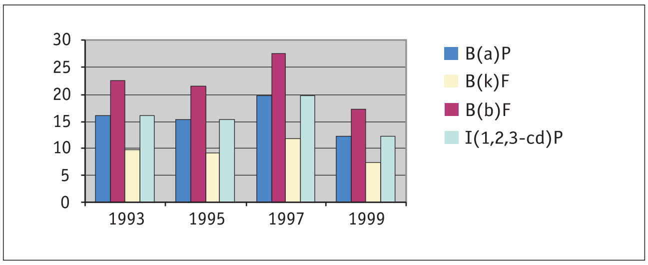


Figure 4.79. PAH (benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]flouranthene, and indeno[1,2,3-c,d]pyrene) emissions from combustion of hydrocarbon fuels in the TAO (including the NIA), kg.

As a rule, specific PAH emissions occurring through coal combustion are higher than those associated with combustion of petroleum hydrocarbon fuels. As coal consumption in the TAO is higher than, for example, in Murmansk Oblast, and the NAO even more so, coal combustion sources dominate PAH emissions from the TAO (Figure 4.81).

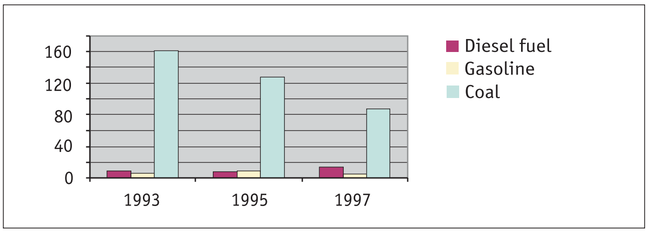


Figure 4.81. Contribution of different types of fossil fuel combustion to benzo[a]pyrene emissions in the NIA, kg.

Dioxins

The use of coal for heat and energy production is a dominant source of dioxin emissions when compared to other types of organic fuel in the TAO. As expected, the NIA is responsible for almost 99.5% of dioxin emissions from coal combustion in the TAO. However, the TAO dioxin emissions from petroleum hydrocarbon fuel combustion (including those from the NIA), are comparable to the dioxin emissions from coal combustion in the TAO when the NIA is excluded.

4.4.5. The Chukchi Autonomous Okrug (CAO)

4.4.5.1. General description

The CAO, which is located in the extreme far northeast of continental Russia, consists of eight districts. These are: Anadyrsky (settlement Ugolnye Kopi); Beringovsky (settlement Beringovsky); Bilibinsky (settlement Bilibino); Iultinsky (settlement Egvekinot); Provedensky region (settlement Provedeniya); Chaunsky (town of Pevek); Chukotsky (settlement Lavrentiya); and Shmidtovsky (settlement Mys Schmidta). The CAO capital, Anadyr, is located in the Anadyrsky District.

According to the census, the population of the CAO was 164783 persons in 1989. In recent years its population has decreased and, by the beginning of 2000, the figure was 72180 persons of whom 49106 are in urban areas and 23074 classed as rural.

The settlements involved in the inventory of local sources are located in three rayons: the city of Anadyr and settlement of Kanchalan in Anadyrsky District, the settlement of Provideniya in Providensky District, and the settlement of Uelen in Chukotsky District. Population characteristics of the inventory areas are presented in Table 4.29.

#	Settlements	Area, km²	Population
1	City of Anadyr	20	11845
2	Anadyrsky Rayon Settlement of Kanchalan	249610	12500 665
3	Chukotsky Rayon Settlement of Lavrentiya Settlement of Lorino Settlement of Uelen Settlement of Neshkash Settlement of Enurmino Settlement of Inchown	30247	4657 1079 1404 844 693 293 344
4	Providensky region Settlement of Provideniya	27286	5067 2137

Table 4.29. Population characteristics of areas in the CAO included in the inventory of local sources.

Variable	1999	2000	Maximum annual discharge in the previous 7 years
Suspended matter	0.7	0.45	2.46
Dry residue	0.41	0.64	0.87
Organic matter (BOD)	2.22	2.29	3.46
Petroleum hydrocarbons	0.01	0.01	0.01
Chlorides	0.55	0.67	0.73
Sulphates	0.28	0.21	0.5
Ammonia nitrogen	0.11	0.12	0.14
Nitrites	0.002	0.001	0.007
Nitrates	0.013	0.029	0.029

Table 4.30. Discharges of contaminants with wastewater in the CAO, thousands of tonnes.

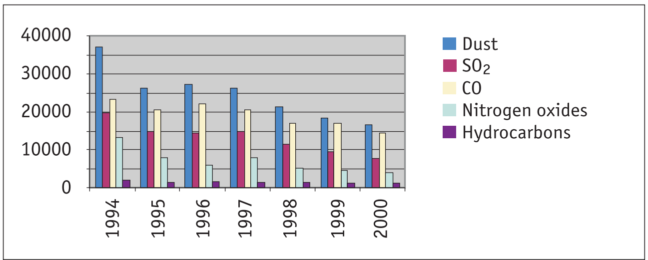


Figure 4.82. Atmospheric emissions of major pollutants from stationary sources in the CAO, t/y.

Main local pollution sources are related to the development of mineral resources such as gold, tin, tungsten, mercury, coal, and lignite. Together, in 1995, industrial entities emitted 72500 t of pollutants into the atmosphere, and discharged 39.3 million m³ of sewage into surface water bodies (including 8 million m³ of polluted wastewater). In 2000, these figures were, respectively, 35500 t, and 20.0 and 5.3 million m³. The main pollution sources are the Pevek Mining and Concentration Plant, the Iultin Mining and Concentration Plant, and also numerous boiler houses.

Provideniya is the biggest settlement inhabited by indigenous peoples in the CAO. The settlement has a seaport, a shipyard terminal, a tannery, and a meat-and-dairy plant. The indigenous population is involved in reindeer-breeding, fishing, the fur trade, and hunting. There are practically no industrial facilities in the settlements of Uelen and Kanchalan where the indigenous population is engaged in reindeer-breeding, hunting, and the fur trade. There are no major pollution sources except for solid household waste and pollution of coastal waters by petroleum products.

Data on air emissions from stationary sources in the CAO are presented in Figure 4.82. Although official statistics do not include data on PTS emissions, there is a well-defined general trend of decreasing emissions. It may be assumed that PTS emissions in this region are also decreasing, in accordance with this general trend. Official statistics on air emissions in the CAO from motor vehicles do not include private vehicles. Based on expert estimates, vehicles used for personal transport exceed the number of vehicles belonging to the state and to the various enterprises by about 50%. Data on air emissions from non-private motor vehicles are presented in Figure 4.83. Official statistics also exclude data on emissions of, for example, lead from the use of leaded gasoline by motor vehicles. This information, based on expert estimates, is provided below.

Official statistical data on pollutants in wastewater discharges in the CAO are presented in Table 4.30. Polluted wastewater is discharged from treatment facilities belonging to the various utilities in the cities of Anadyr and Pevek and the settlements of Bilibino and Iultin. Main areas of pollution were found around the city of Anadyr (affecting 185 km²) and the settlement of Nagorny (affecting 60 km²). Within the inventory area, wastewaters are discharged into natural water bodies without any form of treatment, with the exception of Kanchalan settlement, where effluents are collected from cesspits and transported to the settlement's dump for further partial treatment.

4.4.5.2. Main settlements in the inventory areas

Anadyr

Anadyr is the capital of CAO, and has the most developed infrastructure in the CAO. Emissions for the city of Anadyr, based on State statistical data, are presented in Table 4.31. The city has no wastewater treatment facilities. There are no enterprises registered as potential sources of PCB contamination in the area of Anadyr, and no information on users of PCB-containing equipment. Similarly, there are no industrial wastes in Anadyr which are likely to contain PCB, or hexachlorobenzene (HCB), as there are no activities connected with either their production, or use.

A potential source of brominated flame-retardant compounds (BFRs) is land occupied by municipal landfills, but there are no data currently available on their content due to a lack of information on types of solid household waste dumped at the landfill. In the opinion of experts from the municipal services, household and electronic apparatus that could represent a source of BFRs are seldom found among debris located at the landfills. The Anadyr municipal landfill and is located two kilometers from city. The amount of waste dumped annually in the landfill is 28000 m³. It is important to

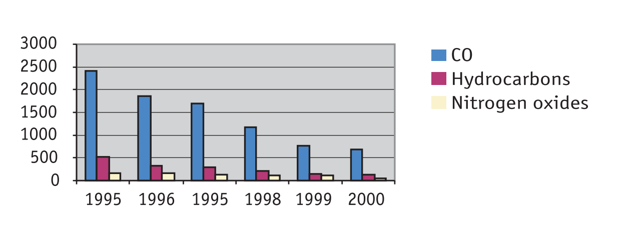


Figure 4.83. Atmospheric emissions from motor vehicles (excluding private cars) in the CAO, t/y.

Variable	1996	1997	1998	1999	2000	2001
Total	4.26	3.94	4.65	3.07	17.002	4.829
Dust	2.90	2.96	3.43	0.23	15.489	3.662
SO_2	0.53	0.51	0.56	1.51	0.463	0.509
CO	0.42	0.22	0.3	1	0.432	0.341
Nitrogen oxides	0.27	0.18	0.36	0.29	0.197	0.282

Table 4.31. Trend in air emissions of major pollutants in Anadyr, thousands of tonnes.

note that landfills in Chukotka are in a permanently frozen state and therefore among the safest landfills and, as certified by the communal services, has low potential for spontaneous combustion. and percolation from the landfill into groundwater.

Although no special studies have been undertaken, and there are no directly relevant data available, it is possible, on the basis of the information presented above, to infer the possible presence of dioxins and furans in the city. Furhtermore, there has been no work associated with organizing an inventory, collection, storage and treatment of mercury-containing luminescent lamps and such equipment.

Kanchalan

The settlement of Kanchalan is located in Anadyrsky District, on the bank of the river Kanchalan, part of the Anadyr river system. At present the settlement has no industry, and agriculture is represented only by reindeer-breeding farms, which only use the settlement as a base. The settlement's housing and municipal services operate a diesel electric power station and a coal-fired boiler-house, which uses coal from the Anadyr deposit.

There is no sewage system in the settlement, and collection is in cesspools, which are periodically cleaned, with the solid waste Being removed to the settlement landfill. According to environmental protection authorities, the level of air pollution in the settlement has never been investigated, and therefore available data is limited to potential sources of PTS only.

Provideniya

The settlement of Provideniya is located to the north of the Gulf of Anadyr, in the Emma Bay (Komsomolskaya). Ureliki village directly adjoins the settlement. Infrastructure in the settlement of Provideniya is similar to that of Anadyr city. The main enterprises are the sea trading port, the airport, a meat-and-milk complex, the 'Providensky kozhzavod' JSC, enterprises run by housing and municipal services, construction operations, and military infrastructure. The port is responsible for the water supply for the settlement. Water is taken from lake Istihet and the river Krasivyi. Effluent discharge amounts to 4.3 million m³. There are no treatment facilities for industrial or domestic wastewater; and practically all waste water from the settlement and port is discharged into the bay of Komsomolskaya. The enterprises listed above are the main water pollution sources.

The following contaminants enter the bay with wastewater: suspended mineral substances (4.32 t), petroleum products (0.13 t), organic matter (24.84 t), chlorides (14.06 t), sulphates (8.33 t), total nitrogen (23 t), surfactants (0.012 t), and phosphorus (0.04 t). Of these pollutants, housing and municipal services release the following: mineral suspensions (3.82 t), organic chemicals (22.31 t), chlorides (12.96 t), sulphates (6.06 t), total nitrogen (2.13 t), and phosphorus (0.04 t).

Air pollution in the settlement of Provideniya and its nearest neighbours, originates from the burning of solid fuel (Beringov coal). In the mid-1990s, about 47500 t/yr were burned in boiler installations. Major pollutant sources include: the thermal power station at the seaport (coal consumption of 9728 t/y), boilers operated by housing and municipal service enterprises (8685 t/y), boilers in the village of Ureliki (7000 t/y), and boiler-houses run by the military infrastructure (7000 t/y).

More than 9600 t of black oil (Mazut) and diesel fuel are burned annually in the settlement. The major pollutant sources include boiler-houses belonging to the seaport and the communal service and diesel-fired power stations.

Annual emissions of pollutants to the atmosphere around Providenya are: 1390 t of dust, 500 t of sulphur dioxide, 750 t of carbon monoxide and 200 t of nitrogen oxides. Emissions from motor vehicles for the whole of Providensky District include: carbon dioxide (256 t), nitrogen dioxide (11 t), and methane (53 t). Mean atmospheric deposition of mineral salts in the areas of settlement for the last few years have been about 50 kg/ha/y, with wet deposition of sulphur at 4-6 kg/ha/yr and nitrogen at about 2 kg/ha/y.

An additional pollution source is solid household and industrial non-toxic debris, which is stored in planned landfills. In total, 33800 m³ of solid waste are exported to landfills each year from all the enterprises within the settlements of Provideniya and Ureliki, and an additional 858 t/y from neighboring villages. There are no data currently available on PTS sources in the area.

Uelen

The settlement of Uelen is administered under Chukotsky District Uelen's infrastructure only includes enterprises belonging to the housing and municipal service departments: the Uelen workshop, farm, and social institutions (consisting of the school, medical station, and kindergarten).

Environmental pollution sources are as follows: the diesel-fired power station, coal-fired boiler, landfill for household debris, coal and ash waste repository, and household heating sources. Air emissions in the settlement in 2001 were: dust (939 t), carbon monoxide (1130 t), sulphur dioxide (668 t), and oxides of nitrogen (536 t).

According to information provided by the local authorities, chlorinated pesticides have not been used in the areas of the above settlements.

4.4.5.3. PTS mobilization from combustion of fossil fuels

As for other project pilot study areas, estimates of PTS emissions from the combustion of organic fuel are based on statistical data on fuel consumption and population distribution. About 30% of the population of the CAO reside in or around the city of Anadyr and the settlements of Kanchalan, Provideniya and Uelen. Due to a lack of data on fossil fuel consumption in the these areas, it was assumed that consumption therefore amounts to about 30% of the total fuel consumption in the CAO as a whole.

Estimates of total PTS emissions from the combustion of fossil fuel in the inventory area are presented in Table 4.32.

Contaminant	1993	1995	1997
Lead	1684.75	1160.70	1033.23
Mercury	3.61	3.30	3.23
Benzo[*a*]pyrene	10.22	6.94	5.61
Benzo[*b*]fluoranthene	11.46	7.20	5.37
Benzo[*k*]fluoranthene	9.31	6.13	5.09
Indeno[1,2,3-*c,d*]pyrene	23.55	18.49	17.42
Dioxins (mg TEQ)	1182.15	1034.29	1004.09

Table 4.32. Estimated emissions of selected PTS from the combustion of fossil fuels in Anadyr, Kanchalan, Provideniya, and Uelen, kg.

Due to the high consumption of local coal, lead emissions to air as a result of coal combustion are far greater than emissions from the use of leaded gasoline, even in the years when leaded gasoline was more widely used.

4.4.6. Conclusions

4.4.6.1. General conclusions

- An assessment of official statistics on the environmental release of pollutants, as well as data obtained by environmental protection authorities of the various administrative territories of the Russian Federation under the scope of the project, clearly indicates that existing environmental release control and reporting systems are not adequate for contemporary requirements. That is, a reporting system suitable for documenting the efficiency of actions taken by countries in connection with international measures to reduce environmental releases of PTS, and in particular the 'Stockholm Convention on Persistent Organic Pollutants'.
- The control and reporting systems of the environmental protection authorities do not adequately cover environmental releases from defence-related activities in the Arctic regions.
- The existing environmental monitoring systems, in almost all cases, do not cover secondary pollution sources; that is sources that are not directly linked to environmental pollution by industrial enterprises, although these may strongly influence the state of the environment, and ecosystems and human health. For example, monitoring of anthropogenic sources such as harbours and ports only covers petroleum hydrocarbons and few other contaminants, and not important PTS that can originate from shipping activities and associated wastes, and particularly from scrapping of ships.

4.4.6.2. Murmansk Oblast

Despite the fact that full, representative figures for releases to the environment are missing for some enterprises and that figures for some of the controlled variables have been obtained by calculation; based on the available information, it is possible to note the following:

- The main persistent pollutants emitted to the atmosphere of this area are copper and nickel, with emissions amounting to about 1000 tonnes per year. Compared to the emission of copper and nickel from industrial enterprises, fuel combustion makes a relatively small contribution to the total emissions of heavy metals in this region.
- Industrial enterprises located in the vicinity of the area where the Saami population is most dense, emit a significant proportion of the total industrial air emissions in Murmansk Oblast. Within the project study area, the most significant pollution source is the 'Severonikel' combined smelter in Monchegorsk. There are a number of other important pollution sources in the area, mainly with respect to heavy metals.
- Emissions of benzo[*a*]pyrene from industrial enterprises are approximately equal to those from the burning of organic fuels.
- According to official data, chlorinated pesticides have not been used and are not currently used in Murmansk Oblast.
- PCB-containing transformer fluids are used in only 13 transformers at 'Apatit' JSC. However, taking account of the high concentration of defence-related activities in Murmansk Oblast, it may be assumed that a considerable proportion of PCB-containing paints, varnishes, and lubricants produced in the former USSR have been used there.

- In general, there are a number of dioxin sources that might be relevant to the survey area. Some enterprises, such as the nickel combined smelter ‘Severonickel’ are considered potential dioxin pollution sources, but no information is available to confirm this assumption.
- Intentional mercury use in industrial production in Murmansk Oblast has not been documented. However, mercury-containing devices, in particular luminescent lamps, contribute to environmental contamination. The enterprise ‘Ecord Ltd.’ involved in handling of used luminescent lamps and located in the area has outdated equipment and itself contributes to mercury contamination of the environment.
- The ‘Severonickel’ combined smelter is considered to be a significant source of mercury contamination in the area due to mercury mobilisation during nickel and copper production. Annual mercury emissions from this enterprise are estimated to be about 0.2 tonnes. In addition, about 0.1 tonnes is accumulated annually in captured dust.
- Coal combustion is considered to be the major contributor to lead emissions that result from fossil fuel combustion. Total lead emissions from the combustion of fossil fuels in the Lovozero area have decreased in recent years, mainly due to a reduction in emissions from motor vehicles.
- Mercury contamination from local sources as a result of fossil fuel combustion is significantly less than that due to mercury mobilization from nickel and copper production at ‘Severonickel’ JSC However, given that domestic coal burning contributes to contamination of the indoor environment, the role of the latter in human intake may be much greater.
- Releases of PAHs from organic fuel combustion have gradually decreased, possibly, due to changes in the types of fuel used. However, after 1998, PAH emissions stabilized, presumably due to the recovery of the economy after the 1997 crisis.
- Industrial enterprises appear to be the main source of dioxin pollution from fossil fuel combustion in the Lovozero area. The role of municipal services, particularly local boilers used for non-centralized heating, in dioxin emissions has significantly increased in recent years. Although still much less than from industrial enterprises, the three-fold growth in emissions from municipal sources within 7 years should be a matter of concern.

4.4.6.3. The Nenets Autonomous Okrug (NAO)

- Main local pollution sources in the NAO are associated with oil and gas production and shipping.
- In spite of the fact that official statistical data do not document significant PTS pollution sources in the lower part of the Pechora basin, the assessment of PTS fluxes in the river flow indicate a possible input of some PTSs between Oksino and Andeg, i.e. in the vicinity of Naryan-Mar. Pollution levels in the Pechora delta tend to be elevated.
- Gas emissions during oil extraction are very high in the NAO, and methods of utilising the associated gas have not yet been developed or applied.
- The port at Nar’yan-Mar, located in a narrow channel connected to the Great Pechora river, is a source of pollution. The port has no treatment facility or storage tanks for liquid wastes and, therefore, wastewater is discharged directly into the river without treatment.
- The system of solid waste collection does not allow for separation of hazardous wastes, including those containing mercury. Disposal of such wastes at landfill sites results in environmental contamination by dangerous substances, which can include dioxins in the event of uncontrolled burning at the landfill site. Methods for handling of medical waste, rubber waste products, and ash and slag waste from boilerhouses has not been developed in the NAO
- Automotive vehicles are the main source of lead emissions in the NAO. The total amount of lead mobilized through fossil fuel combustion is relatively low. However, due to a significant increase in the number of motor vehicles in the area in recent years, an increase in lead emissions has been observed, despite greater use of unleaded gasoline.
- Coal consumption in the NAO is relatively low, since use of petroleum hydrocarbon-based fuels predominates in this region. However, use of firewood as a fuel is relatively common, particularly for domestic heating. As the result, this fuel contributes, for example, about three quarters of the total emissions of benzo[*a*]pyrene, and 80% of total dioxin emissions from the combustion of organic fuel.

4.4.6.4. The Taimyr Autonomous Okrug (TAO)

- The Norilsk Industrial Area, the largest producer of copper and nickel in the Arctic and in the Russian Federation, is acknowledged as the largest single source of environmental pollutants, not only in its immediate locality, but in the circumpolar Arctic. It emits a wide range of contaminants, including a number of heavy metals that fall within the scope of the project.
- Automotive vehicles are an important source of some PTS emissions. The Norilsk area in winter is characterized by numerous temperature inversions, and during these periods, pollution of the lower atmosphere by vehicle exhaust fumes often exceeds pollution from stationary combustion sources.
- About 10 million tonnes of toxic wastes containing over 50 different major pollutants, and more than 1 million tonnes of slag are stockpiled in the Norilsk area each year. Almost none of the waste-storage sites conforms fully to current legal and regulatory requirements.
- According to the results of the PCB inventory for the Russian Federation, significant amounts of PCB-containing fluids are used in electric equipment within the various enterprises of the Norilsk Industrial Area. According to estimates, the transformers used in this area discharge 3.33 tonnes of

PCB annually, and over the whole operating period of the transformers, more than 83 tonnes of PCB will have been released to the environment. In addition, an unknown amount of PCB may enter the environment as a result of releases from PCB-containing paints and varnishes, and compounds used in building construction, etc.

- In 2001, the production of non-ferrous metals in the Norilsk area was accompanied by the mobilization of 1.7–2.02 tonnes of mercury, which was emitted to the atmosphere. In addition, 0.65-0.99 tons of mercury were accumulated in captured dust.
- Dudinka port operates practically all year round. In spite of the fact that it is equipped with an adequate transport infrastructure and oil storage depots, large-scale loading activities, and washout of bulk copper-nickel concentrates causes contamination of the Yenisey river with a range of hazardous substances, in particular heavy metals.
- About 1 million m^3 of waste waters are discharged annually into the Khatanga river from the collector at the Khatanga settlement. There are no data available regarding the chemical composition of the wastewater discharged. The total volume of untreated wastewater discharged in the Khatanga area amounts to 6–8 million m^3 annually.
- The TAO, and the Norilsk Industrial Area in particular, is characterized by high coal consumption levels. Coal burning therefore plays a predominant role in PTS emissions associated with fossil fuel combustion, for example, mobilization of lead. It should be noted that the amount of lead mobilized annually from the combustion of coal in the TAO is greater than the amount emitted by the Norilsk combined smelter during the production of non-ferrous metals.
- Mercury mobilized from coal combustion at heat and power plants contributes up to 10% of atmospheric emissions, the remainder being due to mercury mobilization from ores used in the production of non-ferrous metals.
- Dioxin emissions from the combustion of petroleum hydrocarbon-based fuels in the entire TAO, including the Norilsk Industrial Area, are comparable to dioxin emissions from coal combustion in the TAO when the Norilsk Industrial Area is excluded.

4.4.6.5. The Chukchi Autonomous Okrug (CAO)

- Main local pollution sources in the CAO are related to the development of mineral resources including gold, tin, tungsten, mercury, and coal and lignite. Main pollution areas occur around the city of Anadyr (affecting 185 km^2) and the settlement of Nagorny (affecting 60 km^2).
- Coal dominates organic fuel consumption within the CAO, and, correspondingly, coal burning is responsible for emissions of a number of PTS.
- Sea ports in Anadyr, Lavrentiya and Provedeniya are considered to be local pollution sources.

4.5. Household and occupational sources of exposure

The knowledge accumulated over the last decade about effects of persistent organic pollutants on health indigenous people of the North has caused much public concern about their traditional food considered to be the major pathway of human exposures to highly toxic chlorinated organic compounds and metals. In the meantime other exposure sources and pathways of PTS were generally ignored.

To clarify potential indoor (household) and occupational sources and pathways of exposure, a targeted survey including human blood sampling among selected families and domestic and workplace matters were carried out. The targeted survey was designed as a case study involving 28 families from 3 selected native settlements. The selection of families was based on those measurements of cord blood concentrations of total PCBs derived from the basic survey of the project.

The work programme included re-interviewing and blood re-sampling of those women shown higher cord blood concentrations of total PCBs (over 500 ng/g lipids) at time of birth as well as interviewing and blood sampling of adult family members living together with target women. The referent group has been represented by families of those women found to have lower cord blood concentrations of total PCBs (below 500 ng/g lipids) living either in the same native community or in the closest vicinity of it. It has been proven that the sufficient number (at least 4) of families of “exposed” and “less exposed” newborns were available by the planning period only in:

- the settlement of Lorino, Chukotka coastal study area;
- the district of Khatanga, Taimyr Peninsula;
- and the settlement of Nelmin Nos, Pechora River Basin;

The invitation and interviewing procedures and blood sampling protocol were identical to the those applied for the general indigenous population in the 2001 survey but supplemented with the extended questionnaire focused on occupational and household sources of exposure to PTS since the treatment of animals against mosquito bites, protection of houses against rodents, bed-bugs and cockroaches are widely occurred in the northern communities The work programme thereof involved visiting the houses of selected families as well as work places and, where possible, sampling wash-outs and scrapes in home and occupational settings for further analyses for contaminants. Activities potentially associated with the human exposure to PTS are summarized in Table 4.33.

The impression on to what extent the indigenous population is at higher risk of exposure to PTS through the sources other than local foods can be illustrated by following information obtained from the questionnaire study :

Type of exposure	Site of exposure	Percent of pregnant women reported exposure	Per cent of general population reported exposure
Occupational	fishing/hunting, casting of pellets/plummets	0.9	7.3
	Reindeer herding, lather and fur handicrafts, animal treatment, maintenance female worker, veterinary	10.4	4.63
	Nurse, hospital worker	10.0	4.63
Vegetable gardening	Gardener	19.1	30.5
Use of toxic substances	Any place	41.3	34.1
	At home	39.6	30.96
	At work	5.2	2.3
	In vegetable garden	2.6	0.63
	Against rodents	6.1	3.74
Adverse habits	Smoking	35.2	54.1
	Alcohol abuse (including home-made hard liquors)	57.8	69.9

Table 4.33.
Activities associated with risk of PTS exposure (according to questionnaire).

- Casting of shot (plummet) and other hunting and fishing appliances can hardly be accounted as a source of significant lead exposure in surveyed populations. Only 7% indigenous people and below than 1% of pregnant indigenous women have reported activities potentially associated with contacting lead.
  Smoking is likely to remain one of the most significant source of cadmium intake in indigenous people, since 54% of adults of general population and 35% pregnant women have reported tobacco smoking habits.
- Household use of toxicants is reported by 34-41% of respondents. However, despite the fact that over 30% of surveyed population grow vegetables in garden plots or greenhouses, only few reported on the use of insecticides to protect cultivated plants.
- 70% respondents of general population and 58 % of pregnant women reported the frequent consuming alcohol. The significant number of respondents reported to consume homemade alcoholic drinks. A specific source of PTS contamination is that the indigenous people frequently use, for economical reasons, the wasted (second-hand) technical barrels and plastic containers to produce and store liquids including homemade alcohols.

Chemical analysis of some insecticides sampled as result of targeted survey shows that the most common household toxicants available in the market in Nenets, Taimyr and Chukchi AOs do not contain PCB, HCH, HCB, DDT in considerable concentrations (Table 4.34). The chemical named “Medifox super” produced by “Fox Company” (Russia) is the exception. According to its certificate the main constituent is the permitrin concentrate and “is used for pediculosis treatment and for disinfections of rooms against pediculosis and sarcoptoid ticks”. “Medifox” has been found to be used widely in Chukotka kindergartens, schools, health institutions, residential buildings for scabies treatment since early 1990’s.

“Mashen’ka” crayon imported from China and widely used in the North of Russia for cockroach combating does not appear to contain the POPs in question. However composition of this crayon as well as of other protectors may differ significantly from those used 10-20 years ago. Information about the insecticide composition used in the past, is not available.

The wash-outs were taken indoor (mainly from kitchen walls) whereas the scrapes were taken from surfaces of the kitchen furniture and appliances. Results of their POPs measurements are summarized in the Table 4.35. Judging by these results the indoor environment of indigenous residencies is likely to be one of the most common source of exposure to POPs.

The highest levels of DDT, PCB and HCH were found in the native communities of Chukotka. DDE/DDT ratios in wash-outs and scrapes amount to 10-70 % allow to suggest relatively recent contamination of the residencies by

Name	ΣPCB	HCB	ΣHCH	4,4`-DDE	4,4`-DDT	ΣDDT	ΣTox
“Mashen’ka” crayon	28.0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Anti-cockroach compound	31.0	n.d.	n.d.	7.7	15.0	22.0	n.d.
Medifox (antilice compound)	234	406	n.d.	38.0	480	546	n.d.
Anti-insect compound	8.0	0.5	n.d.	n.d.	n.d.	0.3	n.d.
Anti-gadfly compound	0.3	0.1	n.d.	0.01	n.d.	0.01	n.d.
Anti –mosquito cream	n.d.	1.1	n.d.	n.d.	n.d.	n.d.	n.d.
Anti-mosquito cream	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Skin-tanning fluid	n.d.	n.d.	n.d.	n.d.	0.08	0.08	n.d.
Skin-tanning fluid	n.d.	n.d.	n.d.	n.d.	0.03	0.03	n.d.

Table 4.34.
POPs concentrations in insecticides and in skin-tanning fluids collected in Nenetz, Taimyr, and Chukotka regions in 2003, ng/g

Contaminants	Pechora River Basin	Taimyr	Chukotka	
	Wash-outs, μg / m²	Wash-outs, μg / m²	Wash-outs, μg / m²	Scrapes ng/g
	n=6	n=8	n=11	n=4
ΣPCBs	0.18	1.36	2.35	248.1
HCB	0.02	0.18	0.08	0.8
ΣHCH	0.27	0.28	0.49	67.4
4,4`-DDE	0.28	0.57	0.90	126.3
ΣDDT	1.10	1.85	11.19	768.4

Table 4.35. POPs concentrations in wash-outs and scrapes collected inside the dwellings (geometric means)

DDT – containing chemicals. The intensive past use of household insecticides seems to be the major contributor to the persistent pesticide contamination of indoor environment. However, lack of awareness shown by interviewed indigenous people does not permit to specify the exact insecticide(s) which had been applied indoor. The chemical composition of retailed insecticides is generally unknown since these products had been supplied to the market mostly unlabelled.

The potential occupational exposure to POPs was most frequently reported as in form of the treatment of reindeer skin by various insecticides to protect the animals against mosquito bites. Blood-sucking insects, especially gadflies, can penetrate into animal's subcutaneous tissues as well as through naso-pharynx, impose a serious problem for animal health, and during the long-range running, the efficiency of insect combating may be a determinant of the deer herd livestock. The current variety of chemicals against mosquitoes and gadflies combating are different to those used in the past. Nowadays the most common are the synthetic piretroids which do not contain organo-chlorines, and they are not persistent and not capable of accumulating in the body at detectable levels. In the early 1970's organophosphines (chlorophos) with ammonium carbonate or with sodium hydroxide, hexamide with spindle oil and emulsifier, DDVP (dimethyldichlorvinylphosphate), etacide, trichlorometaphos-3, sulphur dioxide, smoke hexachlorane shells, cryoline-hexachlorane liniment and other hexachlorane compounds were widely used in reindeer collective farms. Among the above-mentioned chemicals only "hexachlorane" has been found to contain HCH at significant levels. Other currently used insecticides are generally free of POPs containing an array of organo-chlorine compounds, and are readily degradable in the nature.