Development of a sustainable Waste Management Concept for Khanty-Mansiysk, Russia

Annex I

- Status quo report -

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ABBREVIATIONS

CIS	Commonwealth of Independence
GDP	Gross Domestic Product
KMAO-Ugra	Khanty-Mansiysk Autonomous Okrug - Ugra
M DEP	Municipal Road - Operational Enterprise
SU	Sampling units

UNITS

kg c^{-1} a^{-1}	Kilogrammes per capita and year
kg c^{-1} w^{-1}	Kilogrammes per capita and week
kg w^{-1}	Kilogrammes per week
Mg	Megagram (1Mg = 1,000kg)
Mg a^{-1}	Megagrammes per year
Mg w^{-1}	Megagrammes per week

DEFINITION OF TERMS

(Sampling) unit is the smallest unit of waste samples, such as a container size of $1m^3$ or a defined weight of waste (EC, 2004).

Coefficient of variation is defined as the ratio of the standard deviation to the mean (EC, 2004).

Commercial waste is defined as waste from small shops, enterprises or administration (EC, 2004).

Confidence interval is an interval in which a test or measurement falls according to a set probability and demonstrates the reliability of a result (EC, 2004).

Confidence level corresponds with the set probability and represents how often the results of the measurements or tests lay within the confidence interval. For example, 90% confidence level means one can be 90% sure that one's results are within the confidence interval. The confidence level is the probability value associated with a confidence interval, often expressed as a percentage. For example, say (1- α), α = 0.10 = 10%, then the confidence level is equal to (1-0.10) = 0.90, i.e. a 90% confidence level (EC, 2004).

Household waste is generated from private households only (EC, 2004).

Sustainable solid waste management includes not only the waste disposal but also takes into consideration all aspects of waste management such as waste generation, collection, transport and recovery in regard to the waste hierarchy: prevention, reuse/ recycling and environmental treatment. Furthermore, intentions of local authorities and interests of all stakeholders which are influenced by waste management should be taken into account within the development of integrated/ sustainable concepts (UNEP, 2009).

Municipal waste is "Waste from households, as well as other waste which, because of its nature or composition, is similar to waste from households." (Directive 99/31/EC on landfill of waste, p. 0003).

Natural coefficient of variation demonstrates the *heterogeneity or variation* of waste and is to be determined by pre-investigation of the waste and stated as the natural variation coefficient (EC, 2004).

Sampling level or level of sampling is the location where the sampling units are taken; for example, inside the household, directly from the kitchen, or outside from the waste containers (EC, 2004).

Stratification: Statistical subdivision of non-homogenous group of waste producers into more homogenous sub-group of waste producer in the research area which does not overlap, for example different residential structure (EC, 2004).

Stratum (sing.)/strata (pl.) is a homogenous sub-group; for example, residents of apartment blocks or residents of small houses with gardens (EC, 2004).

Waste analysis means the quantifying of different waste streams. It also records waste fractions as a proportion of the total waste stream and determines ways of waste disposal and waste practices (EC, 2004).

Waste prognosis is the calculation of waste amount and composition in a future time period, such as in 10 years (Beigl, et al. 2005).

1. Objectives of the status-quo-report

For the project, the discussion and development of a sustainable concept for waste disposal in the town Khanty-Mansiysk was determined as the key objective. Social, ecological, economic data such as information about the infrastructure of Khanty-Mansiysk, existing waste management structure (collection, transportation and treatment/ disposal), knowledge about national/ regional waste legislation and reliable data of relevant waste quantities (amounts generated, recycled and disposed) as well as the material composition (quality) of relevant waste streams are necessary to develop such a concept.

To gather the required information, interviews with representatives of local authorities, waste disposal companies as well as interviews with Russian and European (waste management) experts were carried out. Additionally, information was collected through literature studies and internet research. Furthermore, waste analyses were implemented in Khanty-Mansiysk in February 2011 and June 2011. Following, a market analysis and a prognosis of waste amount and composition were carried out.

In summary, the objectives of the status-quo report are the collection and evaluation of all crucial data required for the development of a sustainable waste management concept. Therefore, all information is summarised in this status quo report and it represents the basis for developing the urban waste management concept in Khanty-Mansiysk.

2. Data and information about infrastructure

There are different factors that have an impact on waste generation and waste composition in a town such as the numbers of inhabitants, the distribution of residential structure, the economy and its development, the heating system, and obviously the current system of waste management. Therefore, relevant data regarding these factors for developing an urban waste management concept were researched and are summarized below.

Although the main focus of this status quo report is on the town Khanty-Mansiysk, it also contains information about the region Khanty-Mansiysk Autonomous Okrug - Ugra (KMAO-Ugra) such as land use, roads, navigable water and railway system. This information is required to make proposals for the location of treatment plants or transport routes for waste from Khanty-Mansiysk.

2.1. Geographical position and land use

Khanty-Mansiysk, the project town, is the capital of Khanty-Mansiysk Autonomous Okrug-Ugra (KMAO-Ugra). Samarovo, the original settlement, was founded in 1637 and is a part of Khanty-Mansiysk today. Khanty-Mansiysk was incorporated as a town in 1952. At present, the area of the town is 33.7 km2.

Khanty-Mansiysk is located on the 61.1st degree of latitude and 69.2nd degree of longitude, in the centre of the West Siberian Plain. It is situated where the rivers Ob and Irtysh flow together. The town is 930 km north from Tyumen[1] and 2,900 km east from Moscow (see figure 1)[2].

Khanty-Mansiysk Autonomous Okrug – Ugra is located in Western Siberia in the Russian Federation (see figure 1). KMAO-Ugra has a north-south length of 900 km and a west-east length of 1,400 km. The size of the area is 534,800 km^2[3] (53,480,000 ha) and occupies 3% of the entire area of Russia (17.1 million km^2). It is one and a half times larger than Germany (357,021 km^2).

KMAO-Ugra is subdivided into 9 municipal districts, 13 towns[4] (see figure 2), 26 small towns and 175 villages[5].

[1] Note: Tyumen is the capital of the Tyumen Oblast in West Siberia. KMAO-Ugra is an autonomous region of the Tyumen Oblast.
[2] Administration of Khanty-Mansiysk, 2011
[3] Administration of KMAO-Ugra, 2011a
[4] Administration of KMAO-Ugra, 2011a
[5] Government of KMAO-Ugra, 2004

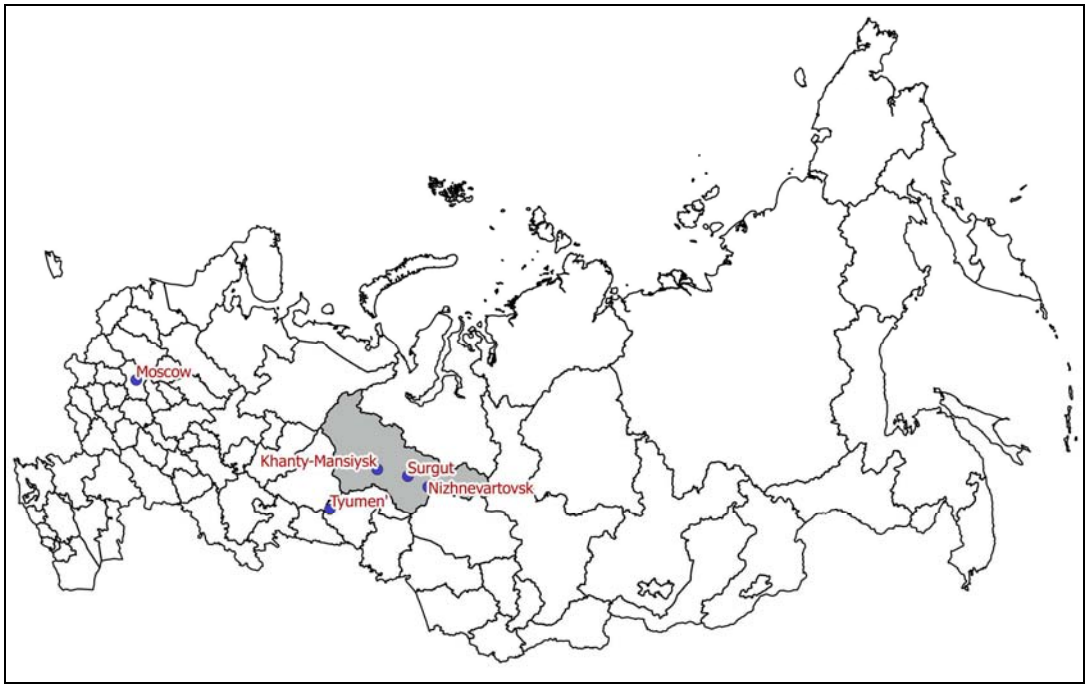


figure 1: Geographical position of Khanty-Mansiysk Autonomous Okrug[6]

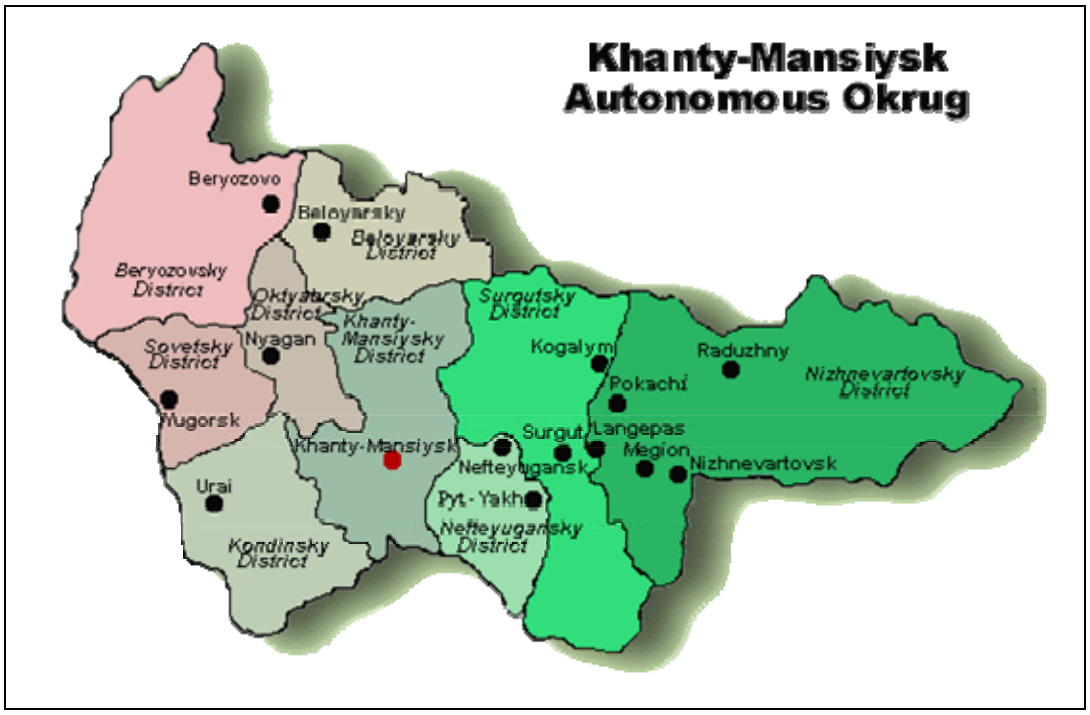


figure 2: Subdivision of KMAO-UGRA into 9 municipal districts and 13 towns (Note: Beryozovo and Beloyarsky are urban settlements and do not have a status of a town. They are the administration centre of Beryozovo district and Beloyarsky district.)[7]

For the development of an urban waste management concept for Khanty-Mansiysk, geographical conditions, including geographical barriers such as mountains or rivers, land use, and location of

[6] Filippova, 2011a
[7] Administration of KMAO-Ugra, 2011b

current waste treatment plant/ landfill site are influencing factors that have to be considered when selecting a site for a treatment plant/ or landfill and transportation of waste.

The territory of KMAO-Ugra is covered by approximately 40% forest on mineral soils, 35% bogs and swamps, 20% forested bogs and fens, and 5% meadows on river floodplains[8]; approximately 60% of the area of KMAO-Ugra is covered by river floodplains, bogs, swamps and meadows (see figure 3).

The pre-dominant land use in KMAO-Ugra is forest resources land/ forest management land (91%). Protected areas account for only 5.7% of land area. Furthermore, 1.3% of the area is covered by towns and villages as well as roads and industrial areas. 1.3% of the land is used for agriculture[9]. Besides a few cattle breeding farms, agricultural activities are limited to mowing of a small part of the floodplain grassland. Agricultural products have to be imported from other parts of Russia[10]. In addition, 1% of the area of KMAO-Ugra accounts for water/ rivers[11].

Currently, 59 registered landfill sites are operated in KMAO-Ugra for municipal and industrial waste (see figure 4) and 60 dumps which just have a permit for working[12]. There are no sorting plants in KMAO-Ugra. However, there are 75 thermal treatment plants for treating:

- medical waste (there are 15 treatment plants so called “Newster-10” which implement a mechanical destruction and thermal sterilization of medical waste),
- biological waste,
- cleaning material from oil production industry,
- waste oils,
- sludge from oil production industry.

Nonetheless, municipal waste is principal disposed on of landfills in KMAO-Ugra. The areas of the landfill sites range between 0.2 ha and 39 ha and a total of 441.7 ha[13] in Khanty-Mansiysk is covered by landfills; i.e. much less than 1% of the entire area of KMAO-Ugra.

The landfill site for the town Khanty-Mansiysk is located approximately 17 km from the town, due north-east[14] and has a size of 20 ha[15].

The system of waste disposal is a de-centralised system; i.e. landfills for municipal waste are close to the towns and villages and they are mainly operated by private or state companies.

Based on the geographical and land use conditions as well as locations of waste disposals the following aspects have to be considered when selecting a site for waste treatment plant and/or landfill site while developing the urban waste management concept for the town Khanty-Mansiysk:

KMAO-Ugra is located in Western Siberia where the climate is severe (i.e. very long and cold winter periods and short and hot summer periods) and bogs and swamps dominate the landscape. 60% of KMAO-Ugra is covered by bogs, swamps, fens and meadows on river floodplains, around

[8] Government of KMAO-Ugra, 2004
[9] Government of KMAO-Ugra, 2004
[10] Administration of KMAO-Ugra, 2011a
[11] Government of KMAO-Ugra, 2004
[12] Administration of KMAO-Ugra, 2011i
[13] Administration of KMAO-Ugra, 2011i
[14] Ivanovich, 2008, interview
[15] Kornienko, 2011b

the area of Khanty-Mansiysk especially as Khanty-Mansiysk is surrounded by two big rivers and their floodplains. In these areas a construction of a landfill site and/ or waste treatment plant is hardly possible and the area for possible waste disposal sites is extremely limited.

Although, federal roads connect the most important towns in KMAO-Ugra, in some villages, there are roads that are useable only during the winter time[16]; i.e. the use, also for waste transportation, is restricted.

The distance from Khanty-Mansiysk to other towns is more than 200 km; i.e. there are long distances for waste transportation.

Khanty-Mansiysk is located in the "Belogorskiy Massif" which has a flat relief (compare also 2.2: Terrains profile, geology and hydrology) and therefore, there are no mountains which limit waste transportation for example to others existing towns.

Although Khanty-Mansiysk is almost entirely surrounded by two big rivers, they do not influence the transportation system. The main roads are built along the Ob; i.e. the roads run to the east-south to Neftyuganz, Surgut, Nischnivartovsk etc. – the biggest towns in KMAO-Ugra.

Currently existing waste disposal sites are located close to towns or villages; i.e. there is a decentralised system of waste disposal. As the distances between Khanty-Mansiysk and waste facilities of other towns are too long, a temporary use of these waste facilities would be neither economically nor environmentally practical.

[16] Company „SibNIPIRP“, Company “KONVEK”, 2006

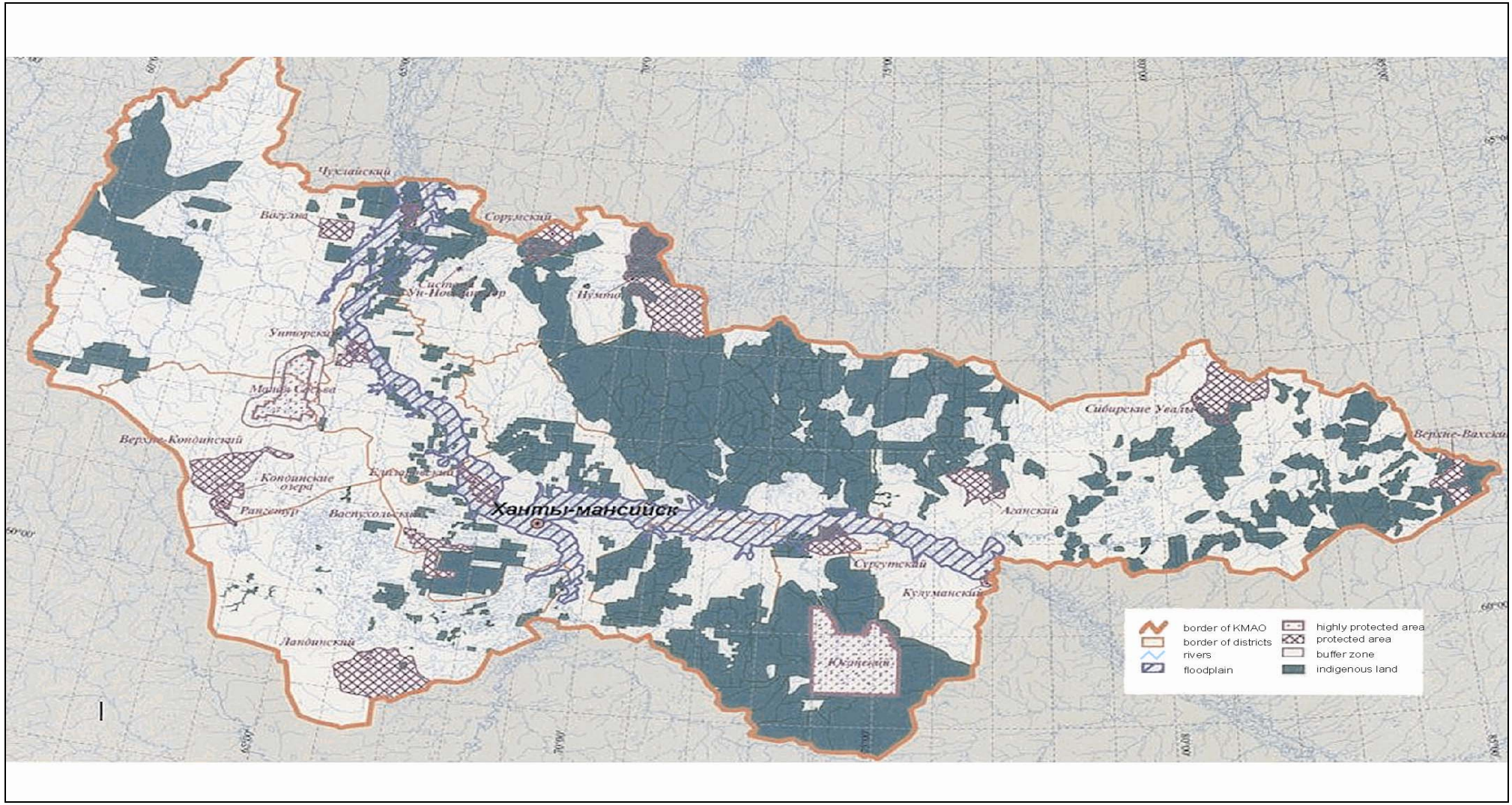


figure 3: Map of land use in KMAO-Ugra[17]

[17] Lapshina, 2011a

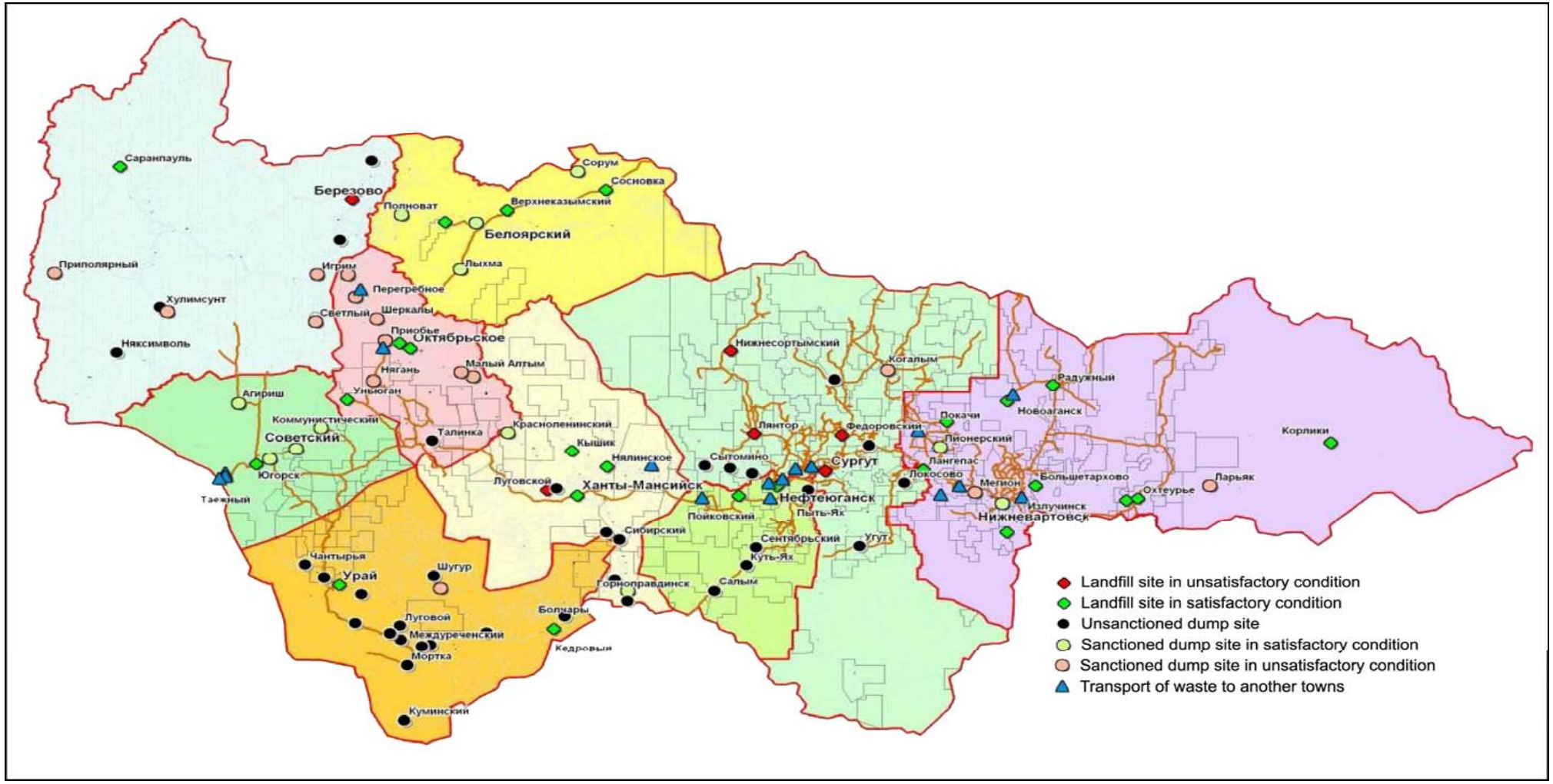


figure 4: Map of registered landfills in KMAO-Ugra[18]

[18] Administration of KMAO-Ugra, 2011j

2.2. Terrains profile, geology and hydrology

Not only the geographical position but also the terrain's profile, the geology as well as the hydrology are site-specific conditions that play an important role for searching suitable places for waste treatments plants. The location for a landfill has to be determined in a way that the geological, hydrological and pedological conditions minimise the risk for ground water pollution by landfill leachate.

KMAO-Ugra occupies parts of "Obskaja Depression" in the west and parts of "Konda Depression" in the east. In the north is the highland "Belogorskiy Massif" and in the north-west are the "Sosva Highlands" and "Ural Mountains". In the north-east the morainic ridge of "Sibirsky Uvala" forms the boundary of KMAO-Ugra.

"Obskaja Depression" and "Konda Depression" have altitudes that vary from 40 to 60 m above sea level. Both depressions are extensively paludified; more than 40 % of the surface area is covered by peat land mires. High "Belogorskiy Massif" has a flat relief with hills and ravines and is up to 95-115 m high. The river Ob has cut through this massif.

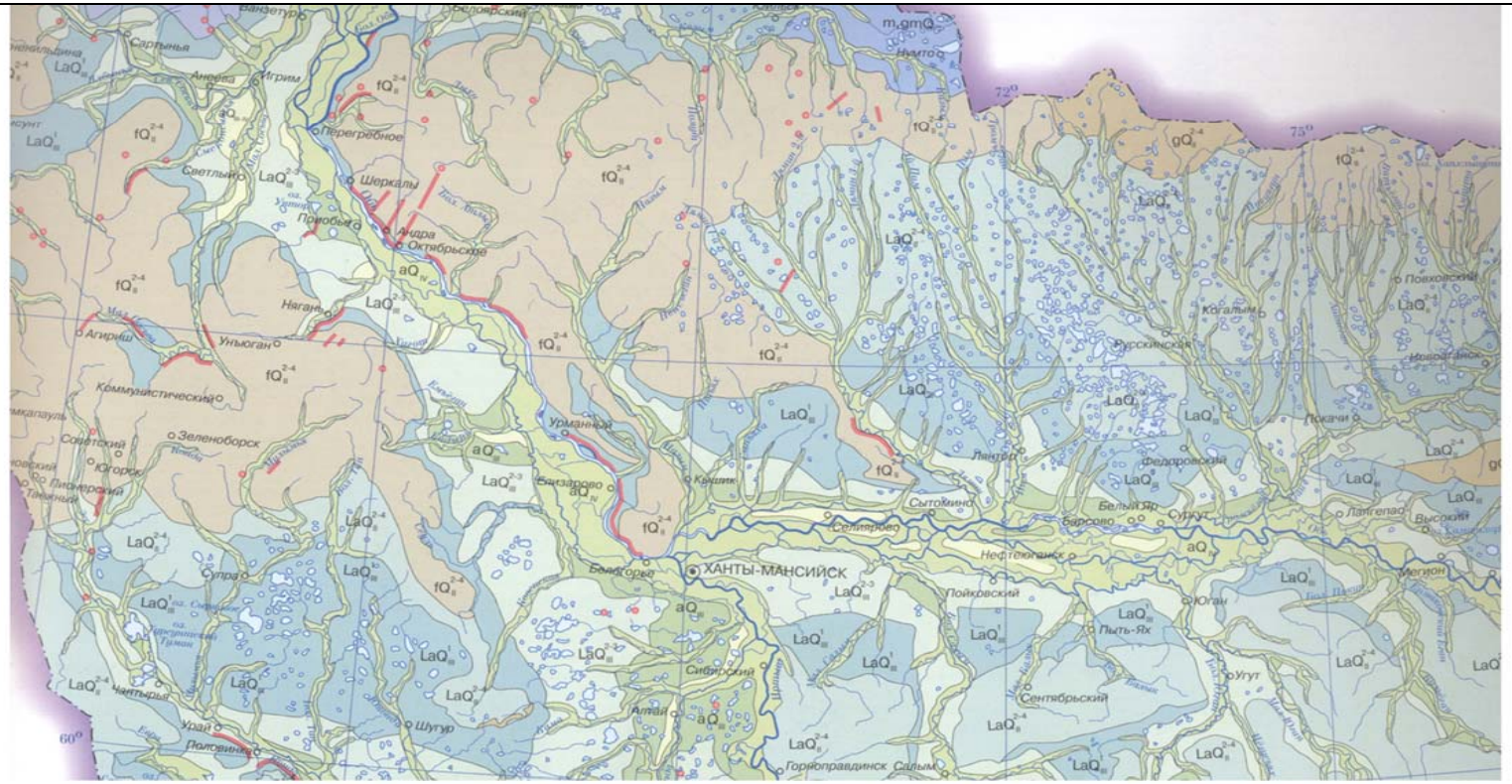
The town Khanty-Mansiysk is located on the southern extensions of the "Belogorsky Massif", safe from erosion by the Ob and Irtysh rivers. The narrow peninsula with the town Khanty-Mansiysk rises several tens of meters above the floodplains of Ob and Irtysh rivers. This raised peninsula is also called "Samarovskiy Hills"[19].

The stratigraphy and lithology of the sediments differ from one municipal district to the other in KMAO-Ugra. Principally, KMAO-Ugra is covered with 40 m of later Pleistocene lacustrine alluvial sediments (clay). There are also smaller layers of clay depending on the location such as hills, bogged areas, floodplain areas etc[20].

The structure of geological stratum near the town Khanty-Mansiysk is very complex. The elevated part ("Samarovskiy Hills") consists of river sediment caused by ice melting. Clay, loam and sandy sediments have been formed and in some places deeper clay material, oversaturated with water has been pushed upwards. Along the slopes of the raised peninsula, colluvial deposits with three Pleistocene terrace levels are present. The floodplains of rivers Ob and Irtysh consist of light clays, sandy clay, clay loam and loams. In the (former) river channels riverbed load deposits consist of sand and gravel[21] (see figure 5).

There are three basic types of soils close to Khanty-Mansiysk: podzol, bog-podzol (forest and bogged forest sites) and alluvial (floodplain sites)[22].

[19] Government of KMAO-Ugra, 2004
[20] Government of KMAO-Ugra, 2004
[21] Ugra Department of Russian Geographical Society, Ugra State University – Institute of Second Education, 2007
[22] Ugra Department of Russian Geographical Society, Ugra State University – Institute of Second Education, 2007



Age	Sediment genesis	Alluvial sediments	Lacustrine and alluvial sediments	Ice sea sediments	Glacial sediments (tills)	Glacio-fluvial sediments	Glacial sediments (tills) and Glacio-fluvial sediments
Quaternary	Holocene	aQ_{IV} aQ_{III-IV}					
Quaternary	Pleistocene late	aQ_{III}	LAQ^{2-3}_{III} LAQ^{1}_{III}		gQ^{2}_{III}		g,fQ^{2}_{III}
Quaternary	Pleistocene middle		LAQ^{2-4}_{II}	m,gmQ_{I-II}	gQ^{3-4}_{II}	fQ^{2-4}_{II}	
Quaternary	Early Pleistocene		LaN_2^2-Q_I				
Tertiary	Pliocene						

figure 5: Geological map of Khanty-Mansiysk[23]

[23] Government of KMAO-Ugra, 2004

KMAO-Ugra has 1,446 streams (rivers of any size) with a total length of 11,569 km as well as more than 1,000 lakes. The main rivers are the Ob and the Irtysh with their tributary rivers Neuleva, Sospas, Severnaya, Malyi salim, Seul, Kovenskaya, Sogom, Lyanim and others. KMAO-Ugra also occupies the West-Siberian artesian basin. It has two groundwater aquifers: The upper, phreatic aquifer is located at 300 m below the surface. The groundwater in this aquifer is fresh and has a very low mineralization degree of less than 1g/dm. The lower groundwater aquifer is an ancient layer of water with a high mineralization level and is used by the oil industry to keep the geological pressure while pumping oil[24].

Khanty-Mansiysk is surrounded by two floodplains of the rivers Ob and Irtish aforementioned and by the many channels in these floodplains. The Irtysh flows into the Ob 16 km north-west from the town. There are many small artesian streams near the town Khanty-Mansiysk, fed by ground water, mostly in the hills. The streams are located at different depths; some of them deeper than 15 m and some of them flows to the surface from the underground (springs)[25]. The drinking water for the town Khanty-Mansiysk is pumped from the groundwater very close to the town Khanty-Mansiysk. There are no designated drinking water protected areas around Khanty-Mansiysk[26].

In summary, the existing hydrology plus the vast area of wetlands extremely limit the options for locating waste treatment plants and/ or landfills in the area around Khanty-Mansiysk (see figure 6). Therefore, these natural conditions have an essential influence on the proposal of a site for waste treatment plants and/ or landfill as part of developing a waste management concept for Khanty-Mansiysk. Furthermore, there is a high risk of pollution of ground and drinking water as well as environmental pollution. The construction of the landfill would have to meet specific requirements in order to prevent uncontrolled infiltration of (ground) water into the body of the landfill and visa verse. However, the landscape is flat and uncontrolled leakage of leachate can be prevented through the construction of a landfill. The existing clay layers can work as a natural barrier. Finally, the high level of ground water, the site restrictions caused by bogs, swamps and river floodplains, the special protection of ground and drinking water will have an influence on the costs for re-construction and re-cultivation of the current existing landfill as well as on the costs for the construction of a new landfill site.

[24] Government of KMAO-Ugra, 2004
[25] Filippova, 2011b, interview
[26] Lapshina, 2011b, interview

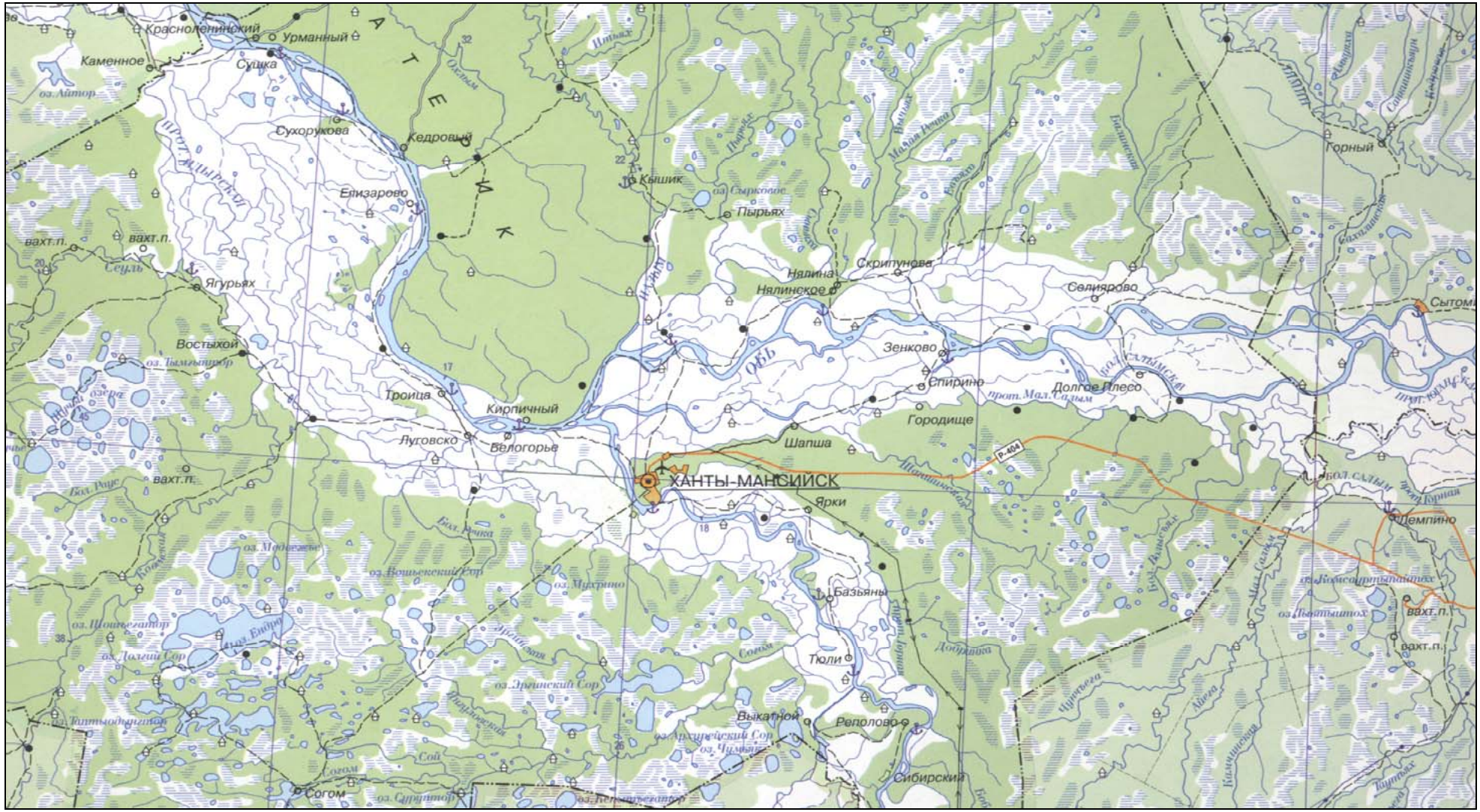


figure 6: Position of Khanty-Mansiysk between the rivers Ob and Irtysh[27]

[27] Government of KMAO-Ugra, 2004

2.3. Climate and Vegetation

As KMAO-Ugra shows severe climate conditions, i.e. very long and cold winter periods and short and hot summer periods, and the typical vegetation zones for this climate, both, climate and vegetation need to be considered for the development of an urban waste management concept. Especially, the climate has an impact on the selection of the collection system as well as on the selection of adequate treatment plants, especially for biological waste treatment plants.

In KMAO-Ugra, the climate is almost continental with an average temperature range between minus 18°C and minus 24°C in January as well as between 16°C and 18°C in July[28]. Temperatures below zero degrees Celsius and snowfall are recorded for seven months per year, from October to April[29]. Spring and autumn can be as short as only one day. Snow depths reach between 50 and 80 cm in the winter period. The average rainfall rate is 400-550 mm per year in KMAO-Ugra. In July and August, the highest precipitation can be recorded[30].

For the climate of Khanty-Mansiysk, town weather variability is typical, in particular during the transition periods autumn-winter and spring-summer. The town is open for cold arctic air that may have a strong impact and can cause sudden changes in temperature (increase/ decrease): in summer between +18°C and +35°C; in winter between -19°C and -42°C. July is the warmest month of the year[31]. The average rainfall rate is 548 mm per year in KMAO-Ugra[32] (see figure 7). Compared to the annual average of KMAO-Ugra, the temperature in the town Khanty-Mansiysk is higher in summer and lower in winter.

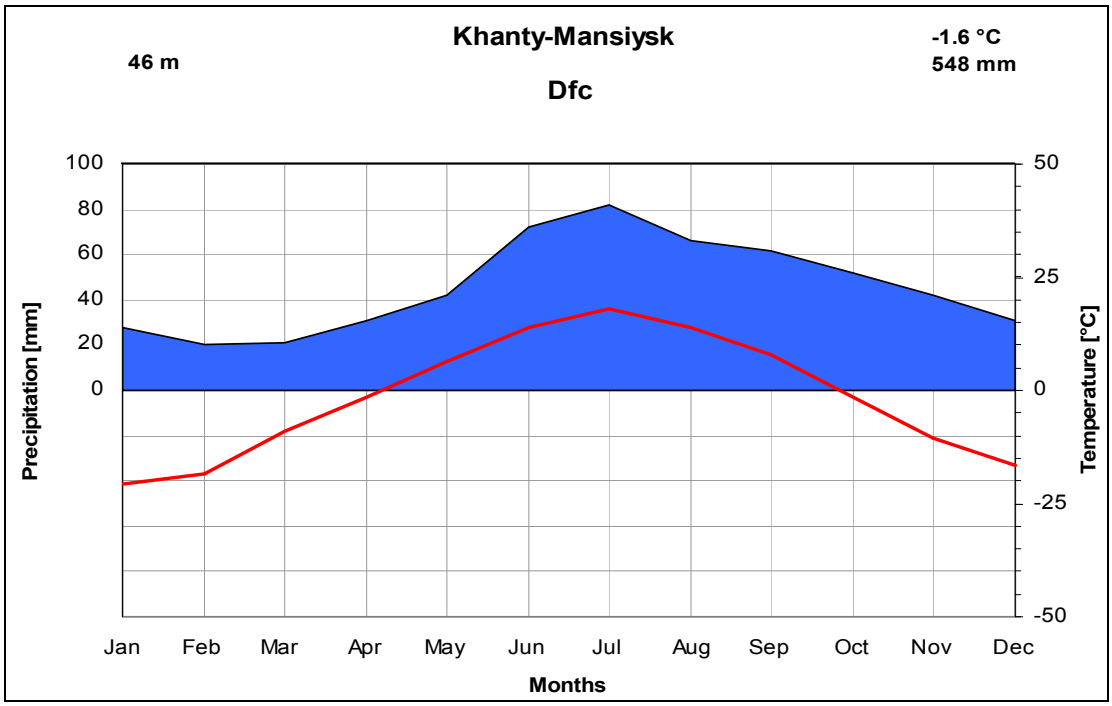


figure 7: Climatic diagram for Khanty-Mansiysk[33]

[28] Administration of KMAO-Ugra, 2011a
[29] Administration of KMAO-Ugra, 2011c
[30] Administration of KMAO-Ugra, 2011a
[31] Kornienko, 2011a
[32] Mühr, 2007
[33] Mühr, 2007

It is noticeable that currently in the winter time, the waste disposal containers are filled with frozen snow, in some cases half of the container. Most of the containers are open containers and there is mainly a daily interval of waste collection. It can be assumed; if the snow starts falling and the container is empty (because of daily emptying intervals) the snow will set on the bottom of the container. Although there is a high rain fall between June and August, this does not influence the waste collection system; i.e. the waste disposal containers do not fill with rain water. In addition, the waste disposal containers are made of steel and do not show any damages caused by the severe climate conditions.

At the moment, there is only an open landfill plant for the treatment/ disposal of waste. The climate has minor influence on the landfill; in summer small fires can occur caused by methane arising from biological processes. However, when considering a biological treatment of waste, it has to be taken into account that an open biological treatment plant would only work restricted as during more than seven months temperatures are below zero degrees Celsius and with snowfall (from October until April). Only from May until September open composting of organic waste is possible.

Not only the climate conditions has to be taken into consideration when introducing the biological treatment but also the question has to be answered whether there is a market for compost or fertilizer – made of organic waste in the biological treatment plant - in Khanty-Mansiysk or in the area of Khanty-Mansiysk.

In and around the area of the town Khanty-Mansiysk there are different types of podzol which are poor of humus (< 1%) and nutrients[34]; i.e. fertilizers are necessary for agriculture. In the town Khanty-Mansiysk, there are 2,149 small houses with gardens (compare *Chapter* 2.5 *Residential structure and heating system in Khanty-Mansiysk*) A lot of these gardens are still used for (urban) agriculture. At the moment, fertilizer made from animal dung is used which comes from small farms from villages around Khanty-Mansiysk or chemical fertilizer is bought by the garden owners[35].

Based on climate and soil conditions, there is no intensive agriculture in the town and in the area around Khanty-Mansiysk. Nevertheless, fertilizer is needed for subsistence agriculture; but it can be assumed that fertilizer is only needed in rather small quantities. For developing an urban waste management concept for the town Khanty-Mansiysk, there is the conclusion that the conditions for operating an open biological treatment plant such as good climate conditions for composting, intensive agriculture and a market for fertilizer are hardly available in Khanty-Mansiysk and in the area around Khanty-Mansiysk.

When researching suitable sites for a waste treatment plant/ landfill site, site-specific conditions such as the vegetation zone have to be taken into account. In KMAO-Ugra, there are two different vegetation zones: the taiga zone covering the West Siberian plain and the Ural mountain.

The taiga zone is subdivided into three sub-zones: south, middle and north taiga with different compositions of trees. The zone of the middle taiga is predominant in KMAO-Ugra. The town Khanty-Mansiysk is located in the middle taiga zone. There are three basic types of vegetation around the town Khanty-Mansiysk:

- forest (watershed and hills area)
- meadows (floodplain area) and
- oligotrophic bogs (watershed area)[36].

[34] Ugra Department of Russian Geographical Society, Ugra State University – Institute of Second Education, 2007
[35] Filippova, 2011b, interview
[36] Ugra Department of Russian Geographical Society, Ugra State University – Institute of Second Education, 2007

Furthermore, in the town Khanty-Mansiysk, there is a woodland park which covers 120 km^{2}[37].

The town Khanty-Mansiysk is like a peninsula, enclosed by the rivers and their flood plains, Irtysh in the north and Ob in the south and west. Only in the east, there is mainly land with forest which is not subject to flooding by the rivers. Nevertheless, this land is also interrupted by bogs and swamps. Therefore, suitable areas for construction in Khanty-Mansiysk and in the area around Khanty-Mansiysk are restricted. In addition, important (valuable) natural landscape as well as the natural park “Samarovsky Hills“ also restrict the extension of the town.

2.4. Transport routes

Khanty-Mansiysk is connected with other towns in KMAO-Ugra and towns in Siberia mostly via federal roads. The nearest towns which can be reached by the road system are Py’tach (250 km), Neftyuganz (160 km), Surgut (300 km) and Njangang (250 km). The most important connections via road are the ones to Neftyuganz and Surgut – as they are the biggest towns in KMAO-Ugra. Another important connection is the road to Py’tach as there is the closest railway station to Khanty-Mansiysk. All these towns are located in the south of Khanty-Mansiysk. There are several main local roads in the town Khanty-Mansiysk:

- The East bypass connects the following main streets: Street Mira with Street Svobody (Samarovo).
- The West bypass connects the airport with Street Ledovaya with Street Svobody (Samarovo).

Furthermore, there are several main intra-urban roads with intensive traffic in Khanty-Mansiysk:

- Street Mira
- Street Kalinina
- Street Gagarina.

The distance from the centre to the airport is 5 km[38].

The intra-urban and federal roads are useable for heavy transport. A well organized winter service cleans the roads quickly and efficient and therefore, the roads are passable for all types of transportation for the entire year.

As KMAO-Ugra is dominated by the river system of the Ob and Irtysh, cargo is also transported by ship on the rivers Ob, Irtysh and their tributary rivers. Approximately 2 million tons of cargos (such as raw materials and materials for construction) are transported by water ways per year[39] and so, cargo transport via ship is an important factor within the transport logistics in KMAO-Ugra. The water ways connect Khanty-Mansiysk with towns outside of KMAO-Ugra such as Omsk, Tobolsk, Tomsk and Novosibirsk in the south of Khanty-Mansiysk and Salekhard in the north of Khanty-Mansiysk. Furthermore, the water ways have access to the sea in the north. The longest routes are:

[37] Kornienko, 2011a
[38] Kornienko, 2011a
[39] Administration of KMAO-Ugra, 2011d

- Khanty-Mansiysk – Berezovo – Salekhard
- Khanty-Mansiysk – Surgut – Tobolsk - Omsk – Novosibirsk[40].

During the navigation period, mainly from April/May to August/ September all 22 territories (13 towns and 9 districts[41]) of KMAO-Ugra can be accessed from the town Khanty-Mansiysk[42].

Although the transportation of cargo via water system plays a significant role in the transport logistic system of KMAO-Ugra (69% of transportation is implemented via water and railway system in KMAO-Ugra[43]), it is limitedly available. The water ways are not passable during the winter period which is seven months per year.

The town Khanty-Mansiysk is not connected to the KMAO-Ugra's railway system. The nearest train stations to Khanty-Mansiysk are in Py'tach (250 km) and in Surgut (300 km). There is transport of cargo possible at the railway stations in Py'tach and in Surgut (equipment for loading and un-loading of cargo is available such as cranes[44]).

Waste transportation from the waste generators (e.g. private households and small enterprises) to treatment plants and/ or to landfills is a significant factor within an urban waste management concept. As described in *Chapter 2.1 Geographical position and land use*, the current waste management system is built on waste disposal on landfill sites which are close to the towns or villages of KMAO-Ugra. The landfill site for Khanty-Mansiysk is just 17 km away from Khanty-Mansiysk. In conclusion, all waste transport ways from waste generation to disposal are accessible the whole year round. Long distance transports of waste and transfer stations for waste do not exist in KMAO-Ugra so far. Long distance transports via trucks, railway or ship seem to be possible but have to be further investigated for concrete cases.

For the preparation of a waste transport system within the development of an urban waste management concept of Khanty-Mansiysk, there are the following conclusions:

Although Khanty-Mansiysk is well integrated into the federal roads and navigable water systems as well as its local roads being in a good condition, Khanty-Mansiysk is relatively isolated compared to other towns in KMAO-Ugra such as Surgut and Neftyuganz; i.e. the ways for waste transport are long and/ or transfer stations have to be implemented on suitable places.

For long distance shipments transportation via water, railway or road comes into question.

Waste transport via water system is available for up to six months per year. It is the cheapest solution. Waste transport via road system has the advantage that it is usable during the entire year it is the most expensive solution.

As Khanty-Mansiysk is not connected to the railway, waste transport via railway system would require transportation to the railway stations in Surgut or in Py'tach. This combination will be profitable for very long distances only.

For selecting the transportation technology and the container systems, the severe climate conditions and long distances between the towns have to be considered; i.e. the transport

[40] Kornienko, 2011a
[41] Kornienko, 2011c
[42] Kornienko, 2011a
[43] Administration of KMAO-Ugra, 2011a
[44] Popova, 2011, interview

technology and containers have to resist low temperature and robust requirements on their material. Furthermore, the container system that will be used, has to be compatible for all three transport systems (road, water and railway system); i.e. the containers have to be suitable for loading onto and transport by truck, ship and train in order to avoid further transferring of waste.

2.5. Residential structure and heating system in Khanty-Mansiysk

To determine the amount and composition of waste from private households and small business activities, the residential structure (including the heating system) and the structure of small shops and handicrafts businesses in the town Khanty-Mansiysk has to be looked at. Differences within residential structures, for example composting of organic waste within suburban areas and non-composting of organic waste within inner city areas, prove to have an impact on waste amount and waste composition. Furthermore, the existence of an internal waste chute had to be ascertained as it can have an impact on the waste composition as well.

The residential structure in Khanty-Mansiysk can be divided into: “small houses with gardens” (1 floor) and “apartment block settlements” (>2 floors) (see table 1). The main emphasis is on the difference between these two residential structures “houses with a garden” and “houses without a garden” in regard to amount and composition of waste, especially the amount of organic waste. One assumption is that people with gardens compost their organic waste partly and that they would therefore produce less waste.

The “apartment block settlements” can be subdivided further. Three types could be identified:

- apartment blocks between 2 and 5 floors,
- apartment blocks with more than 5 floors and
- one-storey apartment blocks.

Houses/ apartment blocks and institutions are mainly heated by gas-supplied boiler houses. Central heating is provided to 84% of housing stock (see table 1). Private houses (small houses with a garden) can have stove heating as well as a gas or fuel-supplied autonomous heating system. On the whole there is a closed heating system in Khanty-Mansiysk[45].

None of the houses of the different residential structures includes an internal waste chute[46].

The apartment block houses can be reached via concrete road; some of the small houses with a garden are just connected with the urban road system via dirt roads.

[45] Kornienko, 2011a
[46] Kornienko, 2011d

table 1: **Residential structure and heating system in Khanty-Mansiysk in 2010**[47]

Residential structure	Number of buildings	Type of heating system
Small houses with a garden (1 floor)	2,149	Individual (such as stove heating) or central heating
Apartment blocks (2- 5 floors)	797	Central heating
Multi-storey buildings (> 5 floors)	66	Central heating
Other residential structure: one-story apartment blocks (2-4 condominiums)	366	Central heating
Total	3,586	---

It has to be mentioned, that many of the apartment block houses are of mixed use and have small shops and handicraft businesses on the ground floor. There are a few shopping centres in the centre of the town or the part close to the harbour. Furthermore, there are some business areas.

For the development of an urban waste management concept, the following factors have to be considered:

The heating system, especially individual systems such as stove heating, is losing its significance for a waste management concept as central heating systems (with a share of 84%) become more and more standard; i.e. the amount of ash which can have an impact on the results of the waste analysis, will decrease.

The town shows a building's open architecture; i.e. most of the buildings stand without contact to the next house. Almost all streets can be used by waste disposal trucks that empty the container (payload of the biggest truck is: 9 Mg). There are only two roads in Khanty-Mansiysk which cannot ride by disposal trucks due to the fact that waste disposal trucks can not enter these streets[48].

The method of road construction allows waste disposal containers to be located close to the apartment blocks, also for collecting separate waste. Some places in the centre have to be looked at in detail as there is a close building method. However, problems could arise for setting waste disposal container for small houses with gardens. When these houses were built, waste container sites were not considered. Currently, the container sites are located in a way, that waste disposal trucks can reach the places. Nevertheless, there are mainly just two containers per container site. For implementing a separated waste collection system, more than two containers are necessary. Therefore, the single waste containers sites for small houses with a garden have to be checked in detail whether more than two waste containers can be set.

There are some business areas in town. The business areas also have concrete roads and waste disposal sites which can be reached via waste disposal trucks.

SanPiN 42-128-4690-88 "Sanitary regulations for settlements", from 05.August 1988 does not allow more than five waste containers at each waste disposal site. Furthermore, the waste

[47] Kornienko, 2011d
[48] Kornienko, 2011d

container site is not allowed to be closer than 20m or not further away than 100 m from a house. Some waste disposal container sites are fenced and it has to be checked whether a container system for separated waste can be accommodated in these places.

2.6. Demographic data

An important part of developing a waste management concept is the calculation of waste amount. The amount of waste from private households is directly related to the number of residents within a town. Therefore, current and 2020 estimated population figures were determined. Beside the population, the population density has also an impact on waste generation, this figure was determined as well.

Since the middle of the 1990s, the population has been growing as a result of the development of the oil and gas industry in KMAO-Ugra. In January 2009, KMAO-Ugra's population was approximately 1.52 million which equates to 1% of Russia's total population (141.9 million inhabitants, 2009). 91.5 % of the entire population of KMAO-Ugra lives in the 15 regional cities/ administrative centre[49]. KMAO-Ugra has a very sparse population density with an average of 2.8 persons per 1 km^2.

The average age of the population is 32.8 years (men: 31.9 years, women: 33.6 years)[50]. This means that there are a high percentage of young people.

In Khanty-Mansiysk, 35,300 inhabitants were registered in 1995. The population has increased rapidly from 39,000 in 2000 to 78,000 in 2010[51] (see figure 8). As registration is not mandatory, the population figures are only estimates by the local authorities, especially since the migration boom in Khanty-Mansiysk.

The future number of inhabitants in Khanty-Mansiysk is estimated by the local authorities at 105,000 residents in 2020[52]. The density of population was 2,315 inhabitants per km^2 in the town Khanty-Mansiysk in 2010.

[49] Administration of KMAO-Ugra, 2011e
[50] Administration of KMAO-Ugra, 2011e
[51] Kornienko, 2011a
[52] Kornienko, 2011a

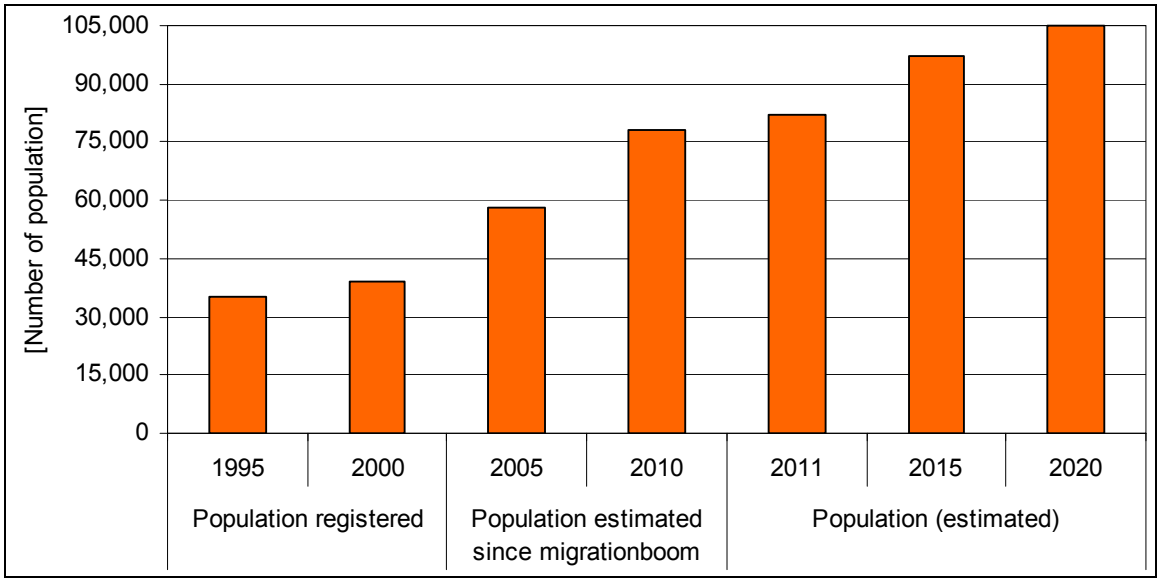


figure 8: Population development in Khanty-Mansiysk from 1995 until 2020[53]

The number and size of households within each residential structure are unknown[54].

For the development of the waste management concept in Khanty-Mansiysk, the following factors have to be taken into account:

A further increase of population in the town Khanty-Mansiysk is expected and therefore, an increase of waste amount has to be considered while developing the urban waste management concept; i.e. for calculating the capacities of waste facilities such as waste treatment and/or landfill as well as waste transportation.

Because of the increasing population in Khanty-Mansiysk a change of the consumer behaviour can be expected. It is also proven that generally in the age group between 15 and 35 years consumption is highest. This also needs to be considered for selecting the type of waste treatment plant.

The after-effect of the migration boom is not only the change of the age structure. As a registration is not mandatory, the number of inhabitants per household and the number of households within each residential structure are unknown in Khanty-Mansiysk. That means that the exact number of inhabitants or household per waste container is also unknown. Uncertainties have to be taken into consideration for calculating the daily or annual waste amount via number of inhabitants or number of household or vice versa for calculating the daily or annual amount per capita or household.

[53] Kornienko, 2011a
[54] Kornienko, 2011d

2.7. Economic development

The waste amount and composition, especially of commercial waste, is significantly connected with the economic branches, their distribution and their expected economic development. Indicators to describe the economic development are the Gross Domestic Product (GDP), the average income or the unemployment rate.

2.7.1 Economic sectors of Khanty-Mansiysk Autonomous Okrug-Ugra

Relevant economic branches for describing the regional economy in KMAO-Ugra are industrial production, trade and service as well as electric power industry (see figure 9). KMAO-Ugra is one of the most important extractors of oil and gas as well as of electric power generation in Russia[55].

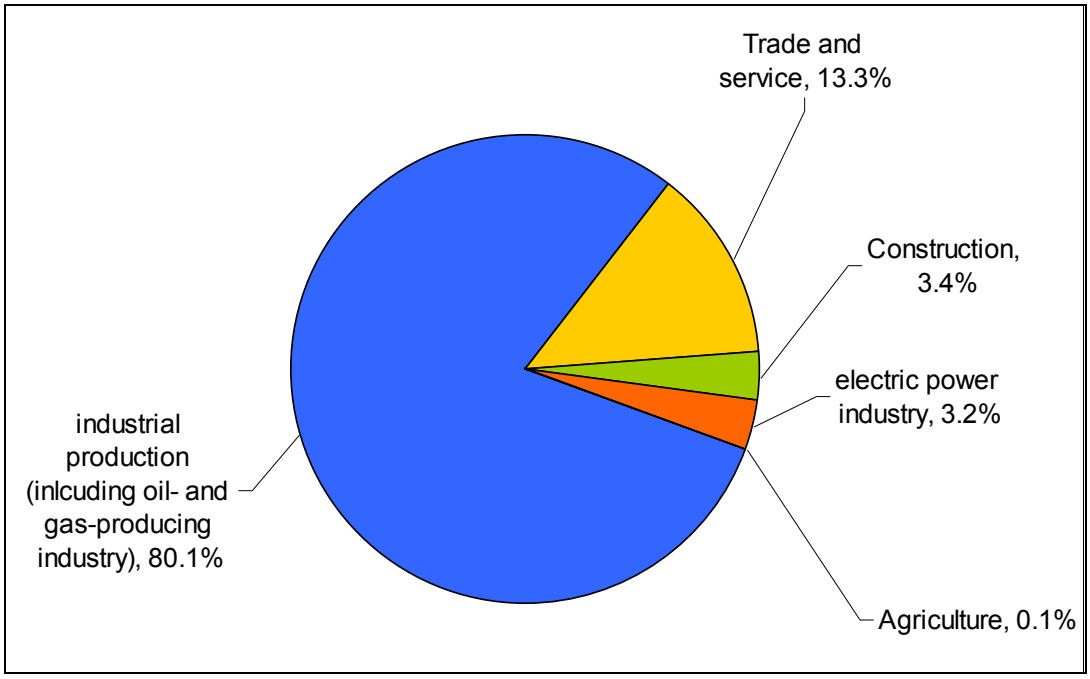


figure 9: Economic sectors based on their percentage of total turnover in KMAO-Ugra in 2010[56]

In contrast to the region's economy that is pre-dominantly industrial, the town Khanty-Mansiysk was developed and built mainly as an administrative town. In total, there are more than 1,743 organizations and enterprises in Khanty-Mansiysk[57]. According to the number of employees, the economic sector "small business" and "Governance, military security and social insurance" are the key economic sectors in the town. Regarding the annual turnover, the relevant economic sectors are "construction", "communications" and "provision of other services (culture, sports, and recreation)". Although the economic sector "small business" is the key factor in regard to number of employees, data regarding turnover could not be determined. Businesses have to have more than 15 employees in order to be included in the statistical assessment of each economic sector (see table 2).

[55] Administration of KMAO-Ugra, 2011a
[56] Government of Russian Federation, 2011
[57] Administration of Khanty-Mansiysk, 2011

table 2: Economic sectors in the town Khanty-Mansiysk in 2010 based on number of employees and the turnover[58]

Economic sector	Number of employees	Share of employees [%]	Turnover [1,000 Roubles]	Turnover [%]
Small businesses	12,046	24.4	-no data-	-no data-
Governance, military security and social insurance	7,714	15.6	105,000	0.5
Education	4,950	10.0	496,191	2.4
Health and social care	4,864	9.8	175,383	0.9
Real estate	4,502	9.1	940,205	4.6
Provision of other services (culture, sports, recreation)	2,874	5.8	2,626,901	12.9
Transportation	2,658	5.4	2,235,999	10.9
Construction	2,602	5.3	4,544,485	22.2
Financial activities	2,289	4.6	-no data-	-no data-
Production and distribution of electricity, gas and water	1,330	2.7	1,575,233	7.7
Hotels and restaurants	1,062	2.1	442,727	2.2
Wholesale and retail trade, repair of motor vehicles	866	1.8	2,170,196	10.6
Communications	827	1.7	2,695,445	13.2
Mining and quarrying	423	0.9	200,961	1.0
Manufacturing activity	244	0.5	1,869,527	9.2
Agriculture, hunting and forestry	132	0.3	273,858	1.3
Fishing	61	0.1	73,029	0.4
Total	**49,444**	**100.0**	**20,425,140**	**100.0**

2.7.2 Tourism as an relevant factor of economy in Khanty-Mansiysk

Khanty-Mansiysk has a well developed tourism infrastructure and tourism is a significant economic factor. The number of tourists was approximately 98,000 in 2009 and 2010 (see table 3). The tourists are mainly from Russia. Foreign tourists are from the Commonwealth of Independence (CIS) und the European Union. In average tourists stay for 2.5 days[59].

[58] Kornienko, 2011f
[59] Kornienko, 2011e

table 3: Numbers per quarter and nativity of tourists in 2009 and 2010[60]

	2009		2010	
Quarter of the year	**Number of tourists from Russia**	**Number of foreign tourists**	**Number of tourists from Russia**	**Number of foreign tourists**
I	19,475	732	19,956	619
II	14,216	72	8,999	576
III	16,313	639	10,614	871
IV	44,442	715	56,037	769
Total	**94,446**	**2,158**	**95,606**	**2,835**

The town hotel capacity exceeded 1,500 rooms with 17 hotels in 2010[61]. The number of tourists is mainly influenced by international events in Khanty-Mansiysk.

In 2010, Khanty-Mansiysk hosted:

- 39th World Chess Olympiad (18.09. – 15.10.2010)
- 65th Victory Day celebration
- 80th anniversary of Khanty-Mansiysk (Ostyak–Vogulsk) autonomous okrug – Ugra.

Furthermore, the annual international debut film festival “Spirit of Fire” (last week of February), the Ecological festival “Save and Preserve” (June), the World Cup Biathlon (March), and the TV festival “Golden Tambourine” (late September) are also key attractions for tourists.

In addition, based on the “Federal Law about the specific economic areas in Russia, from 22.July 2005, No.116, the Government of KMAO-Ugra decided to propose a recreational specific economic zone. It is the first one in Siberia. The aim of this zone is to promote the economic sector including tourism. At the moment, the zone has not been approved by the Government, yet. However, according to the local administration, tourism should play a significant factor within the economic development[62].

It can be summarized that tourism is a part of the economy in Khanty-Mansiysk and the aim of the local authorities is to increase its contribution to the economy by facilitating its development. The tourism main season is in winter between October and March as most of the events take part at this time such as the annual World Cup biathlon, annual Film and TV festival. In contrast to the main season for visitors, residents leave the town for vacation mainly in spring and summer, late December as well as early January.

For the development of an urban waste management concept, the seasonally high number of tourists has to be taken into account. The local authority determines the number of tourists by counting the registered overnight stays in hotels[63]. During the biathlon in March 2010, visitor numbers were estimated at more than 22,000 in just two weeks[64] . However, the number of

[60] Kornienko, 2011e
[61] Kornienko, 2011e
[62] Kornienko, 2011c
[63] Kornienko, 2011g
[64] Administration of KMAO-Ugra, 2011j

overnight stays during this quarter is stated as 20,575 (see table above); i.e. for (international) events a higher number of tourists can be assumed than there are registered by the hotels.

In conclusion, it has to be considered that more people are in town during the winter period than in the summer period as more tourists are in Khanty-Mansiysk. Additionally, summer is the main period for holidays and it can be assumed that many inhabitants leave the town for holidays. As the solid household waste and commercial waste similar to household waste such as waste from hotels depend on the number of inhabitants/ hotel occupancies, it can be summarized that a seasonal variation of the amount needs to be considered while developing the waste management concept; especially for calculating the capacity of the waste treatment plant, for Khanty-Mansiysk.

2.7.3 Gross domestic product and average income

Studies have proven that a higher GDP results in higher amounts of waste. The regional Gross Domestic Product (GDP) (nominal) per capita in KMAO-Ugra was 34,693 Euro in 2010[65]. Although only approximately 1% of the Russian population lives in KMAO-Ugra, the share of the national Gross Domestic Product (nominal) in Russia was 4.6% in 2010. In comparison with the GDP per capita of Europe-27 and Germany, KMAO-Ugra produced the highest GDP per capita (see figure 10). Furthermore, the forecast of the OECD (2008) for 2025 predicts that KMAO-Ugra will have the highest GDP per capita comparing to Russia, European Union and Germany.

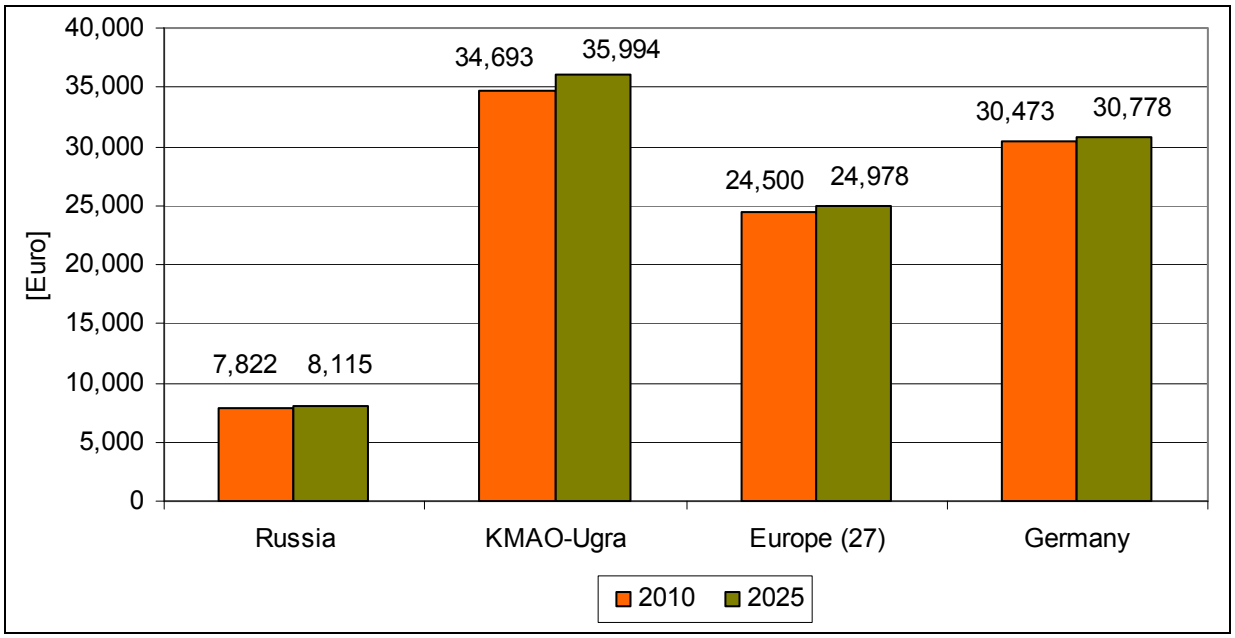


figure 10: Average gross domestic product per capita (nominal) in Euro in 2010[66]

With the recent economic growth in KMAO-Ugra, the average gross income was 1,003 Euro per capita and month[67] and therefore, it is higher than the average gross income in Russia which was 421 Euro[68] per capita and month in 2009. In comparison, the average gross income was 2,304 Euro per capita and month in Germany in 2009[69] (see figure 11).

[65] Government of Russian Federation, 2011
[66] ***Russia:*** current GDP – Germany Trade & Invest, 2011a; prognosis – OECD, 2008/ ***KMAO-Ugra:*** current GDP – Government of Russian Federation, 2011, prognosis: as there are no data, the prognosis of Russia was taken – OECD, 2008/ ***EU (27):*** current GDP – Eurostat, 2011, prognosis – OECD, 2008/ ***Germany:*** current Germany Trade & Invest, 2011b, prognosis – Prognos AG, 2009
[67] Administration of KMAO-Ugra, 2011f
[68] Germany Trade & Invest, 2011a
[69] Germany Trade & Invest, 2011b

In Khanty-Mansiysk, the average gross income has increased extremely from 36 Euro per month in 1995 to 586 Euro per month in 2005 and 868 Euro per month in 2010. A further increase is expected and predicted to be 1008 Euro in 2014[70] (see figure 12). The unemployment rate is under 1 % in the town Khanty-Mansiysk. Furthermore, the average gross income in Khanty-Mansiysk is higher than the average gross income in KMAO-Ugra.

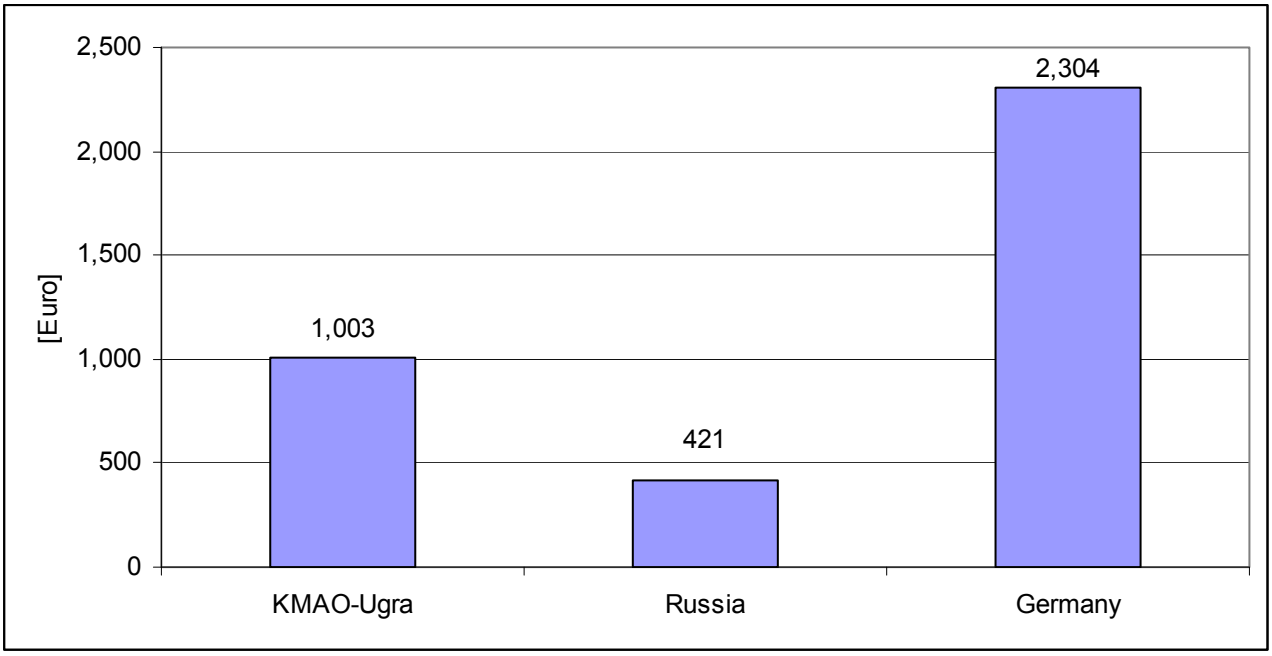


figure 11: Average gross income in KMAO-Ugra, Russia and Germany per capita and month in 2009

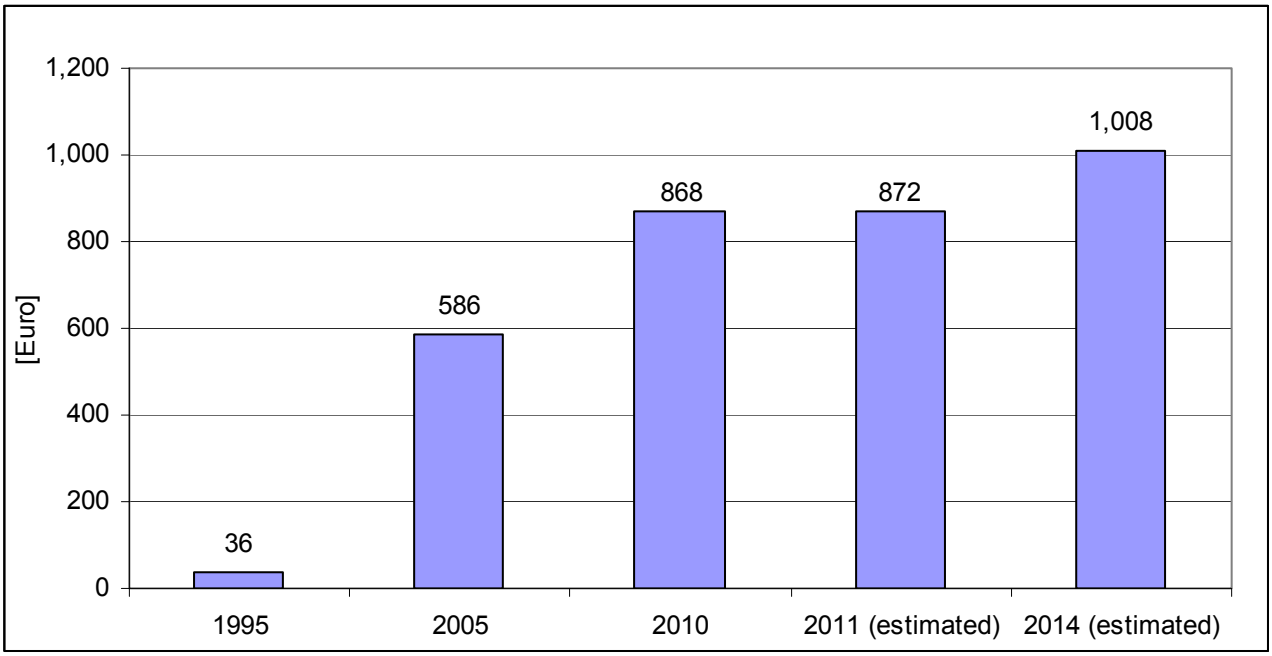


figure 12: Development of average gross income in Khanty-Mansiysk between 1995 and 2014[71]

[70] Kornienko, 2011a
[71] Kornienko, 2011a; figure for 2014: Kornienko, 2011f

2.7.4 Future development of economic sectors in Khanty-Mansiysk

Currently, there is no forecast for the development of the different economic sectors for the town Khanty-Mansiysk and the number of employees in each sector. However, the local administration assumes that most of employees will work in the non-production economic sectors such as “Education”, “Governance, military security and social insurance” as well as “Provision of other services (culture, sports, and recreation)”.

The local administration of Khanty-Mansiysk wants to strengthen and expand the following economic sectors:

- enterprises for fish reproduction of valuable species (sturgeon, whitefish)
- cattle breeding, including dairy products
- companies involved in the production of souvenirs and basket weaving
- plants for the recycling of solid waste and recycling of liquid wastes, including the production of heat or (electric) energy.

Furthermore, a “Strategy for socio-economic development of the town until 2020” is being developed at the moment and should be adapted by the administration at the end of June 2011. A program until 2015 which supports small business has already been approved. The main objective is to strengthen the local food industry, the agriculture and the consumer market[72].

In conclusion, KMAO-Ugra shows stable economic conditions with a growing economy. The town Khanty-Mansiysk shows an increase of the average gross income per capita for the next years. An increase of the economy/ GDP, including an increase of the average income, results in social changes and in higher rate of consumption. This again results in an increase of waste amount and change of waste composition, especially of solid household and commercial waste. Furthermore, it is proven that higher income households produce more waste, but the percent of recycling is the same as in poorer income households[73].

While developing a new waste management concept for the town Khanty-Mansiysk, it has to be considered in which way the concept can be funded. However, although the GDP per capita (nominal) of KMAO-Ugra is high, the gross income is less; i.e. the income of the inhabitants of Khanty-Mansiysk does not reflect the high GDP. That has an influence on the budget for the future waste management concept as the local administration mainly has to take over the costs. At present, the local administration of the town Khanty-Mansiysk is already principally paying for the waste management as there are gaps in the legislation to enforce payment (compare also *Chapter 3.1 Collection and transport system of solid municipal waste*). However, according to the polluter-pays principle, economic incentives and legislative conditions should be implemented to allow for user charges that will co-finance the waste management concept.

As it is also planned to strengthen the economic sector „ fishing”, “agriculture (mainly the cattle breeding)” as well as branches connected with tourism, branch-specific waste management strategies, including reimbursement, have to be considered in the urban waste management concept for the town Khanty-Mansiysk.

[72] Kornienko, 2011f
[73] OECD, 2008

3. Existing waste management structure in Khanty-Mansiysk

In order to develop a sustainable and well-functioning waste management concept, the performance of the current waste collection and the used disposal technologies (refuse vehicles and treatment facilities) has to be evaluated.

3.1 Collection and transport system of solid municipal waste

In Khanty-Mansiysk, several private and one governmental waste disposal companies collect solid waste from waste containers (kerbside collection) which are located on different sites in the entire town as well as collecting directly from shops or companies without using waste containers.

The entire waste generated in Khanty-Mansiysk is transported by waste disposal trucks to the governmental landfill site (TBO landfill). Two pick-up methods are used to collect the waste: machine-operated and manual. Vehicles with machine operated picked-up systems compact the waste before transferring to the landfill site. There are neither transfer stations nor waste treatment facilities in Khanty-Mansiysk. The different waste streams such as household and commercial waste will be disposed of without any pre-treatment[74]. An exception is the medical waste; before this waste stream is disposed of on the landfill, it is sterilised (in "Newster-10"[75]) and burnt in order to avoid bringing hazardous waste to the TBO landfill.

Some waste streams are collected separately: Since 2009 bulky waste is collected separately every two days. The bulky waste is dumped next to the waste containers for household waste by the inhabitants of Khanty-Mansiysk and the waste disposal companies collect it separately (see figure 13)[76]. At the moment it is not treated or used as recyclable materials. Bulky waste is only transported to the landfill without any treatment. Furthermore, there are no data about the composition of the bulky waste in order to identify recyclable materials[77]. It is to be assumed that the bulky waste mainly consists of furniture and mattresses, hardly electronic waste.

Construction and demolition waste is also collected separately. At the moment there are no figures for the amount or composition of construction and demolition waste either. Construction and demolition waste is disposed on non-registered landfill close to Khanty-Mansiysk[78].

[74] Kornienko, 2011a
[75] Administration of KMAO-Ugra, 2011j
[76] Kornienko, 2011d
[77] Inozemcev, 2011c, interview
[78] Inozemcev, 2011a, interview

figure 13: Bulky waste disposed of close to waste containers by the inhabitants[79]

The collection and transportation of construction and demolition waste takes place directly through the construction companies such as “VNCC”[80].

There are six enterprises in charge for waste collection in Khanty-Mansiysk. Municipal Road - Operational Enterprise (M DEP) is the governmental company and the biggest in town. The other five companies are private and very small in comparison:

- LLC «Aktsent»
- LLC «Cleaning company «Schisty Dom»
- Individual Entrepreneur (IE) Leshchenko L.M.
- LLC «Eco-Service»
- “Communal and transportation service“„.

More than 590 people work for these six companies[81]. The town council pays for the majority of waste disposal[82].

In total, more than 27 compactor trucks and more than 10 non-compactor waste disposal trucks with different size exist in Khanty-Mansiysk (see table 4).

[79] Kaazke, 2011
[80] Inozemcev, 2011d
[81] Inozemcev, et al., 2011a (Note: There are no data about the number of employees from “Schistie dom”).
[82] Tomsha, 2007

table 4: List of waste disposal trucks grouped by companies in Khanty-Mansiysk[83]

Name of organisation	Type of refuse vehicle	Number of refuse vehicle	Compactor vehicle	Size of each refuse vehicle [m^3]	payload [Mg]
M DEP	Kamaz MKM-4605	6	yes	17	9
	Kamaz MK3-4602	2	yes	18	7
	Zil-433362 MKZ	1	yes	9,5	4.5
	Gaz KO-440-2	2	yes	8	3,1
	Maz-5357-044	1	yes	16	-no data-
	Gaz Saz - 3507-01	2	no	5	4.3(open load area)
	Maz -5337-04	1	no	12	Crane (lift capacity: 16Mg)
	Maz -5337-045	3	no	18	for liquid waste (capacity:16Mg)
	Maz - 533702-2140	3	no	15	- no data -
LLC «Aktsent»	Kamaz KO-440-5	1	yes	22	8.5
	Kamaz MKZ 447-01-01	1	yes	22	8
	Kamaz MKZ 447-01-01	1	yes	22	8
IE Leshchenko L.M.	Kamaz	2	yes	7	-no data-
	Kamaz	1	yes	16	9
LLC "Eco-Service"	Zil- KO 424	1	yes	9	3.8
"Communal and transportation service"	Gaz KO-440-2	4	yes	13	3.1
	Kamaz 65111	5	no	9	14
LLC Cleaning company "Schisty Dom"	-no data-				
Total		**37**			

[83] Inozemcev, et al., 2011b (Note: There are no data about the number of waste disposal trucks from "Schistie dom").

Beside the six waste disposal companies, more than 30 of private companies and private persons transport and dispose of their waste on their own using the landfill of the town Khanty-Mansiysk[84].

In Khanty-Mansiysk, there are approximately 1,785 waste containers on circa 760 sites for municipal solid waste and they are mostly emptied every day[(85)]. The size of these containers is between 0.55m^3 and 1.1m^3. There are three types of waste containers; two types of containers are open container and one type is a closed container (see table 5).

table 5: Type, size, volume and number of waste containers in Khanty-Mansiysk

Type of container	Size of container	Volume of container	Number of container	Picture of container[86]
Small open container; standard container	Height: 85 cm Width (top): 85x85 cm Width (bottom): 70x70 cm	0.55 m^3	1,675	
Big open container	Height: 130 cm Width (top): 100x100cm Width (bottom): 90x90cm	1.1m^3	40	
Close container	Standard size	1.1 m^3	70	

[84] Inozemcev et al., 2011a
[85] Inozemcev et al., 2011b
[86] Kaazke, 2011

M DEP disposes of the waste of approximately 1,500 containers; the other five companies are responsible for the emptying of the other 285 containers. The containers are the property of the firms[87].

In conclusion, the collection and transport system was built up in the recent years; in 2006 there were three waste disposal companies and 75 employees were registered. Currently, there are six companies with more than 590 employees; i.e. there is a development of waste disposal as an economic factor and employers. In addition, approximately 1,500 containers were set in the town until 2006. In 2010, approximately 1,785 containers already exist. From 2006 until 2010, the infrastructure for waste disposal (such as number and size of containers, number and size of waste disposal trucks) had already reached their limits as the infrastructure was not calculated for such a high number of inhabitants caused by the migration boom. A new investigation in equipment for waste collection and transportation was already necessary.

It can be stated, that the entire amount of waste is transported out of town every day. The town Khanty-Mansiysk does not have problems with litter; exceptions are waste container sites as waste containers can be filled more than 100% in less than 24 hours and so, the volume of the waste container does not seem to be sufficient. A higher volume of containers is necessary (see figure 14).

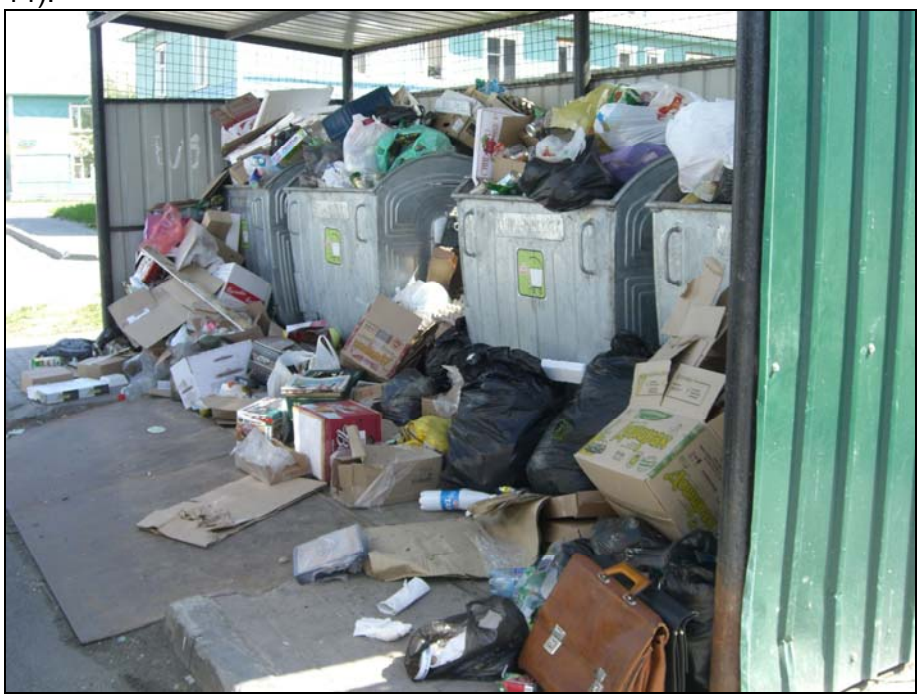


figure 14: A waste disposal site in Khanty-Mansiysk[88]

Currently, there are no waste containers for collecting municipal waste separately. However, separated collection at source of different waste streams for recycling is only useful if there are waste sorting plants and a market for recyclable materials.

In summary, although the volume of waste containers is not sufficient, the collection and transportation system works efficiently as all waste generated is collected and transported to the landfill each day.

[87] Matveev, 2011, interview
[88] Kaazke, 2011

3.2 Waste facilities of municipal solid waste

In Khanty-Mansiysk, there is only one governmental landfill (TBO landfill) for the disposal of solid waste for the town and surrounding villages. The total territory of the waste disposal site is 20 ha. The waste disposal site was opened in 1999; the disposal period is planned for 18 years - until 2017[89].The TBO landfill is approximately 17 km from the town, due north-east[90].

The capacity of the prepared places for waste disposal on the landfill was planned for 2,071,915 m^3 of waste. By 2010, 2,187,114 m^3 of waste was already disposed which is 6 % above the planned capacity[91]. Almost 8 ha are already occupied by waste[92].

There is no sorting, recycling on the landfill site and there is no incineration plant in Khanty-Mansiysk. A sterilization plant (so called “Newster-10”) exists in the town Khanty-Mansiysk to sterilize and to burn the medical waste as there are two important hospitals (the biggest hospital in KMAO-Ugra and the tuberculosis hospital) as well as several small ambulances.

Only municipal solid waste can be disposed of on the landfill of Khanty-Mansiysk; i.e. waste of category VI-V risk classes which only include very low or non-hazardous waste[93] (see *Chapter 6.3 Definition of waste and waste holder, waste classification as well as waste cadastre*); industrial waste is not allowed to be disposed of on the TBO landfill in Khanty-Mansiysk. Different types of municipal waste are not collected or disposed of separately. All municipal solid waste (including hazardous waste) generated in Khanty-Mansiysk is disposed of on the landfill without any treatment[94].

In November 2007, a weighbridge was constructed at the entrance of the waste disposal site. Since then the weight of every waste collecting vehicle has been measured but the type of waste has not been analyzed or documented[95]. The weighing process that which is implemented is very crucial. The weight of waste that is disposed on of the landfill site can be measured on daily basis and used for record purposes. The result is stored in the database.

Furthermore, a collecting system for leachate, rain and melting snow was built on the waste disposal site and an average of 8 m^3 water per day was collected and transported to the sewage plant in 2008[96]. At the moment, there is no measurement of amount of rain water and/or melting snow[97]. Furthermore, neither methane nor landfill leachate has been measured yet, but there are plans to measure and capture the methane. The soil and groundwater below the landfill site is protected from any contamination of the waste by a layer of HDPE foil.

The disposal site structure consists of two alternating layers: 2 m of disposed waste and 0.2 m of soil. At the dumping ground a dozer is used in order to disperse and compress the waste very well and soil is spread on the waste in order to keep the mound of waste passable for garbage trucks. The planned absolute height is 15 m[98].

[89] Thomsha, 2007
[90] Ivanovich, 2008, interview
[91] Inozemcev, 2011b
[92] Kornienko, 2011b
[93] Kornienko, 2011a
[94] Kornienko, 2011a
[95] Ivanovich, 2008, interview
[96] Ivanovich, 2008, interview
[97] Ivanovich, 2011, interview
[98] Ivanovich, 2008, interview

Additionally, a landfill site for only snow exists in the winter period (see table 6). Snow arises from October until April; street sweeping does not occur in the wintertime. The disposal of snow is a huge problem in Khanty-Mansiysk as the snow itself is waste as it is polluted by chemicals such as exhaust fumes and, when melted, can pollute the ground- and surface water. Additionally, the snow is extremely polluted with glass bottles, bins, dust etc. Some nets are built around the snow hill every year and are supposed to retain the waste that is in the snow, but this does not work very well. The snow is currently disposed of on a landfill site which is very close to the river Irtysh in Khanty-Mansiysk. If it thaws, large amounts of melt water flow into the river without over flooding the town[99].

table 6: Size and equipment of registered landfill sites

Name of the landfill	Responsibility	Total size of area [ha]	Total capacity [m^3]	Equipment of landfill
TBO	M DEP	20	415, 176	1. Weighbridge at entrance 2. Rainwater collection system 3. Bio-thermal pit 4. Reinforced concrete pit for wheel washing 5. Observation wells
Snow landfill site	M DEP	6.6	-	6. No equipment

The assessment of the current waste management structure shows the following issues:

- The prepared places for waste disposal on the landfill site are already filled above capacity. New places are prepared at the moment. The total capacity of all places for waste disposal is planned to increase to 6,288,000m^3.

- Expanding the landfill or opening a new waste disposal site is essential in order to bridge the time gap until the new waste management concept is implemented. At the moment, the possibility whether the former waste disposal place (which is located on the landfill site) can be used again is investigated by the local authorities. The geological conditions (compare also *Chapter 2.2 Terrains profile, geology and hydrology*) limit the area for waste disposal sites; i.e. the waste amount generated in Khanty-Mansiysk has to be reduced.

- A temporary use of a landfill from another town for disposal of the municipal waste from Khanty-Mansiysk is both neither ecologically nor economically reasonable as distances between Khanty-Mansiysk and waste facilities from other towns are too long (compare *Chapter 2.1 Geographical position and land use*).

Although there is a scale at the entrance; the waste amount is still recorded in m^3. This suggests that the scale is not used as intended. Experiences prove that this can lead to un-reliable data, especially while planning the capacity of waste treatment plants. The measurement of the unit “ton” has to be implemented. The equipment for this kind of measurement is already available.

The waste composition (of the waste transported to the landfill) is not recorded and waste screening at the landfill site should be implemented. If the waste transported to the landfill is not

[99] Rybik, 2005, interview (Note: Mr Inozemcev (2011a) confirmed that still the snow landfill is located there.)

municipal solid household waste as per definition, a sampling and quick analysis of pollutants should be carried out in order to avoid ecological problems.

3.3 Collection, transport and treatment of waste water

The sewage treatment facility (KOS) in Khanty-Mansiysk was brought into operation in December, 1997, with the installed load being about 7,000m^3/day. It is a biological treatment plant. In 2005, the first stage of treatment facility reconstruction was completed which resulted in an increased efficiency from 7,000 to 12,800m^3/day in 2006 and an improved quality of sewage water treatment.

On average, sewage treatment facility treats 10,000 m^3/day. Maximum sewage waters brought to KOS is 14,800 m^3/day.

KOS in Khanty-Mansiysk operates in hydraulic overload conditions. Waste waters are collected in a close reservoir/ single septic tanks and are pumped to waste water disposal trucks and then transported to KOS in Khanty-Mansiysk. The sewerage network length is 99.5 km in Khanty-Mansiysk. 46.8 km of 99.5 km of polyethylene sewerage networks belongs to MP «Vodokanal».

23 sewage pumping stations are involved in pumping sewage water, 14 of them belong to «Vodokanal» (assets).

The treated water is discharged into the river Ob through a canal and the sewage sludge is disposed of on a place behind the sewage treatment facilities (see figure 15).

figure 15: Sewage treatment facility in Khanty-Mansiysk in 2011[100]

[100] Filippova, 2011a

Population growth, equipping buildings with services and utilities, bringing into operation new many-storied houses, private houses and public facilities construction caused an increase in water consumption and waste water discharge[101] and the capacity of KOS has reached its limits. Therefore, at the moment single septic tanks are removed and a central sewage system is installed. Furthermore, the construction of new sewage sludge treatment facilities with an efficiency of 25,000-30,000 m^3/day is needed to improve housing services and utilities, to provide a greater number of consumers with water discharge service.

In summary, the expansion of the sewage treatment plant has to be considered during the development of the urban waste management concept for Khanty-Mansiysk, especially for selecting the waste treatment plant.

[101] Kornienko, 2011a

4. Waste generation and prognosis

For developing a waste management concept, knowledge about the current waste generation and a prognosis of future waste generation is essential. In co-operation with representatives of M DEP and the Department for Architecture, housing and communal service, the following waste streams were verified for the town Khanty-Mansiysk:

- Solid household waste and
- Commercial waste- similar to household waste (e.g. waste from schools, universities and public offices/administration, business offices, hotels, restaurants, shops)
- Bulky waste,
- Street cleaning residues including snow and waste from litter bins,
- Garden and park waste,
- Market waste,
- Construction and demolition waste
- Medical waste
- Wastes from water treatment plants
- End-of-life tires Metals/End-of-life vehicles
- Waste from veterinary clinics/livestock farms.

4.1 Total waste generation in Khanty-Mansiysk

The Department of town-planning, architecture and housing and communal services as well as M DEP record the amount of waste in Khanty-Mansiysk. Since 2004, there have been annual figures for waste disposal given in cubic meter (see table 7). These figures were estimated by counting the waste collection trucks running to the landfill[102]. 1,648,711 m^3 of waste were disposed of by 2010.

[102] Kisileva, 2008a, interview

table 7: Annual waste amount disposed of on the landfill between 2004 and 2010[103]

Year	Waste amount [m^3]
2004	195,300
2005	200,597
2006	210,600
2007	246,700
2008	297,240
2009	244,494
2010	253,780
Total	**1,648,711**

In total, 2,187,114 m^3 of waste are estimated to be disposed of on the prepared places on the landfill site close to Khanty-Mansiysk from 1997 until 2010[104] (compare also *Chapter* 3.2. Waste facilities of municipal solid waste).

As mentioned above, the total amount of waste generated in Khanty-Mansiysk can be subdivided into different waste streams which were determined in the town Khanty-Mansiysk (see table 8). Mainly, the figures have been determined in cubic meter. In some cases, figures have not been determined yet, therefore estimations were necessary.

[103] 2004 - 2007: Kisileva, 2008b; 2008 - 2010: Kornienko, 2011b
[104] Kornienko, 2011b

table 8: Waste amount generated in Khanty-Mansiysk in 2010

Type of waste	Total amount [Mg]	Notes
Solid household waste and commercial waste similar to household waste (such as waste from schools, universities and government agencies/ administrations, commercial firms, hotels, restaurants, shops)	**28.945,6**	29,125.6 Mg[105] were measured as solid municipal waste on the scale at the landfill in 2010. This figure also includes medical waste (Note: after sterilisation with the waste treatment plant "Newster-10" - medical waste can be disposed of on the TBO landfill[106]). The medical waste was subtracted from the figure 29,125.6Mg. Therefore, not 29125.6 Mg but **28.825,6** Mg is disposed of on the landfill as household and commercial waste in Khanty-Mansiysk.
Waste from street cleaning and waste from bins, including garden and park waste, waste market as well as waste from the snow landfill site after snow melting	**142.8**	1,368 $m^{3(107)}$ was collected as waste from the streets etc. in 2010. There are special cars/ trucks which collect the street cleaning residues and waste from litter bins etc. The volumes of the cars are counted but the amount of waste in the cars is not measured separately at the weighbridge of the landfill site. Additionally, the place of the landfill site for snow is to be cleaned as well -after the melting of the snow. .Between 1 and 2 trucks of each 30 m^3 are filled with the waste from this place[108]. In total, 1.428 m^3 of waste from street cleaning etc. generated in 2010. It is assumed that 1m^3 corresponds with 100kg.
bulky waste	**2.700.00**	The figure for demolition/construction and bulky waste generated in 2010 is estimated at 22,728 $m^{3(109)}$. The volumes of the waste disposal trucks were added. Construction waste is disposed of close to the river Irtysh. Bulky waste is disposed of on the TBO landfill. Since 2011, bulky waste is measured on the landfill site via scale but not regularly; therefore no reliable figure exists. Figures of 18,000 m^3 for bulky waste and 4,728 m^3 for demolition waste[(110)] are estimated. Khanty-Mansiysk is a very new town and mainly houses are built at the moment. Only few wooden houses were demolished in the recent years; therefore there is only a small amount of demolition waste. It was assumed that 1 m^3 corresponds with 150 kg.
Demolition and construction waste	**710.00**	
Medical waste	**180**	The main hospital in Khanty-Mansiysk is responsible for sterilisation of all kinds of medical waste in the town. There is no information about the treatment and/or disposal of the ash from the sterilisation plant "Newster-10"[111]. When medical waste is treated by the

[105] Inozemcev, 2011d
[106] Slyusar, 2011b, interview
[107] Kornienko, 2011a
[108] Inozemcev,2011e, interview
[109] Inozemcev, 2011b
[110] Inozemcev,2011e, interview
[111] Alikhanov, 2011, interview

Type of waste	Total amount [Mg]	Notes
		"Newster-10", it can be disposed of on the landfill as TBO[112], and it can be assumed that this is done. The main hospital has a capacity of 560 beds and hosts 17,000 patients per year. The main hospital disposals in average 30 Mg per month on the landfill[113], it was assumed that the half of it corresponds with medical waste/ash treated by the "Newster-10". The other half of waste is similar to household waste - waste from the kitchen, from the small shops etc. Therefore, 15 Mg per month or 180 Mg per year in 2010 can be estimated as medical waste in Khanty-Mansiysk which was disposed of on the landfill from the hospital itself.
Waste from veterinary clinics / livestock farms and pets	**0.75**	1,343 dead animals were counted in 2010[114]. Veterinary medicine waste is not measured via scale on the landfill. According to Mr Iwanowitsch, approximately 100 kg of veterinary medicine waste was delivered to the landfill from January to March 2011 (it includes dead animals). Usually, 4 times per year the veterinary laboratory brings this amount of waste[115]. Furthermore, M DEP has the order to eliminate wild dogs[116]. The number of dead animals of wild dogs is included in the total number of 1,343 dead animals. In the book where the dead animals are counted it was recorded that 100 kg of rats were collected in April 2011. Usually, there is a water rat problem in April of each year when the level of the rivers raises and the rats have to flee from their nests because they are flooded[117]. This kind of waste is disposed of in a bunker and is treated with a liquid solution. The bunker has a size of 300 m^3 and is not full, yet. The bunker has been in use for more than 5 years[118]. Therefore, the following estimate of veterinary waste was made for 2010: - 400 kg from the veterinary lab - 100 kg from water rats - 250 kg from wild dogs. In total, 750kg of veterinary waste was assumed.
Snow	**528.229**	812,660 m^3 snow is disposed of on an extra landfill close to the Irtysh[119]. A density of 0.5 to 0.8 Mg/m^3 can be assumed for disposed snow.
Total	**560.908,15**	

[112] Slyusar, 2011b, interview
[113] Inozemcev, 2011d
[114] Inozemcev, 2011b
[115] Ivanovich, 2011a, interview
[116] Elesina, 2011, interview
[117] Kaazke, 2011
[118] Ivanovich, 2011a, interview
[119] Kornienko, 2011a

Further waste streams could be identified (see table 9) but there are no figures, as these waste streams are not counted. Figures for end-of-life-vehicles and end-of-life tyres are estimated.

table 9: Further waste streams generated in Khanty-Mansiysk

Type of waste	**Total amount** [Mg]	**Notes**
End-of-life-vehicles	48	End-of life vehicles are not collected on the landfill; data from garages does not exist[120]. According to Mr Usman[121] and Mr Matveev[122], approximately 20 cars were de-registered in Khanty-Mansiysk in 2010. The "Road control" will get an official letter from Mr Usman to find out the de-registration of cars and trucks etc. The answer will be given by the "Road control" in 1 month at the end of July 2011[123]. It was assumed that one car equals 0.8 Mg/m^3.
End-of-life tyres	313	End-of-life-tyres are not collected in Khanty-Mansiysk. Companies which generate end-of-life-tyres are responsible to dispose of them by themselves[124]. Approximately, 68 Mg of end-of-life tyres per year are generated by M DEP only[125]. M DEP has a contract with the company "Beresokow" which took 100 tyres for recycling in 2010. Estimating that all the private waste disposal companies together have the same number of waste disposal trucks as M DEP – they will also produce approximately 70 Mg end-of-life tyres per year. Furthermore, it is also assumed that the one big public transport company and the two big construction companies produce the same amount of end-of-life tyres as M DEP. In total, there are 4 company groups each producing 70Mg of end-of-life tyres; i.e. in total 280 Mg a^{-1}. In addition, 20 de-registered cars produce approximately 3 Mg of end-of-life tyres and inhabitants with a car produce 30Mg of end-of-life tyres. In total, 313Mg of end-of-life-tyres can be expected per year.
Toxic Waste	- no data -	Hazardous waste is not collected methodically. During the research for the status quo report, **oil-stained materials, car batteries, transformer oils, pesticides, asbestos and waste electrical and electronic equipment (WEEE)** were investigated as toxic waste. There are mainly ***oil-stained materials***

[120] Inozemcev, 2011c, interview
[121] Alikhanov, 2011, interview
[122] Matveev, 2011a, interview
[123] Alikhanov, 2011, interview
[124] Elesina, 2011, interview
[125] Inozemcev, 2011c, interview

Type of waste	Total amount [Mg]	Notes
		from repairing cars and trucks (sometimes from airplanes). Oil-stained materials are burned on the landfill - if they are recognised in the waste[126]. Oil-stained materials from MDEP are delivered separately and burnt on the landfill. Approximately 1.12Mg of oil-stained materials was delivered to the landfill site only from the company MDEP in 2010[127]. ***Car batteries*** are valuable in Khanty-Mansiysk and therefore, they are sold instead of disposed on the landfill. However, if a car battery is found in the waste disposed of on the landfill site, it will be taken out and stored in a waste disposal container, specially prepared for such a waste at the moment, the container is empty[128]. M DEP generated approximately 1.3 Mg car batteries in 2010[129]. ***Transformer oil*** is collected in tanks and is brought to other towns. There are no figures[130]. ***Pesticides for agriculture*** are not used as there is only subsidence agriculture[131]. The use of ***asbestos*** in construction was stopped 5 years ago. Houses with asbestos have not been demolished, yet[132]. ***Waste electrical and electronic equipment (WEEE)*** is not collected separately. WEEE and bulky waste can be dropped off next to the waste containers. It is disposed on of the landfill as well. There are no figures[133].
Waste from waste water companies	- no data -	This waste is disposed of on an area behind the water treatment plant; the amount is unknown.

According to the data of the Department of town-planning, architecture and housing and communal services and M DEP, mainly solid municipal waste is collected in Khanty-Mansiysk. In order to identify the composition of this waste stream, waste analysis of solid household and commercial waste was implemented.

[126] Ivanovich, 2011a, interview
[127] Inozemcev, 2011c, interview
[128] Ivanovich, 2011a, interview
[129] Inozemcev, 2011c, interview
[130] Elesina, 2011a, interview
[131] Lapshina, 2011b, interview
[132] Alikhanov, 2011, interview
[133] Inozemcev, 2011c, interview

4.2. Implementation of analysis of solid household and commercial waste

Waste analyses of solid household and similar commercial waste were implemented in Khanty-Mansiysk in February 2011 and June 2011. The waste analysis followed the model of the "Methodology for the Analysis of Solid Waste (SWA-Tool)" by the European Commission[134].

As the water content of the waste is also an essential factor for developing a waste management concept; i.e. the choice of the waste treatment plant, the analysis of water content was implemented. For the analysis of water content, the standard "DIN ISO 11465 - Soil quality-Determination of dry matter and water content on a mass basis- Gravimetric method, March 2005" was used.

In compliance with the SWA-Tool, it is necessary to take multi-stage random but also representative samples of waste, as it is not possible to analyse the whole determined research area such as a town. Random samples allow the estimation of the entire quality and quantity of waste of a research area. It is required to define stratification criteria in order to obtain representative random samples. The tool describes several decisive factors for a standard waste analysis:

- Type of waste sampling and stratification
- Sampling level, type of sampling units and calculation of sampling size
- Duration of a waste analysis and
- Sorting catalogue.

The residents were not made aware of the waste analyses to avoid changing their behavior and, consequently, the waste composition and amount. The analysis followed the same system in all seasons. In the end, the separated waste was weighed and disposed of.

The type of sampling used is the stratified random sampling method with defined stratification criteria. The stratification criteria selected *are waste origin, residential structure, and seasonality*. These criteria are chosen as they have an influence on waste amount and waste composition of the solid household and commercial waste in Khanty-Mansiysk:

Residential structure

Four main structures exist in Khanty-Mansiysk:

- small houses with a garden (1 floor),
- apartment block settlements (>1 floor),
- apartment block settlements (>1 floor) combined with business and
- commercial areas.

The main emphasis of the stratification of residential structure is on the difference between these residential structures in regard to amount and composition of waste, especially the amount of

[134] EC, 2004

organic waste. One assumption is that people with gardens compost their organic waste partly and that they would therefore produce less waste.

Season

Seasonal analyses are important as it can be assumed that people change their living behaviours at different times of the year depending on the season and weather. Furthermore, the heating period plays an important role because ash can have an impact on the results of the waste analysis. For this reason, temperature is an important condition and was determined when the waste analyses were carried out.

Waste origin

As waste origin solid household and commercial waste are chosen. The disposal of solid household and commercial waste proves to be one of the biggest problems regarding waste management in Khanty-Mansiysk caused by the extreme development of the town as well as population growth.

The external waste containers in front of the apartment blocks and small houses are the chosen sampling level.

As sampling unit (u), the bin volume is taken in Khanty-Mansiysk. Two containers with a volume of 0.55 m^3 each equal 1 unit of 1.1 m^3 or one container with a volume of 1.1 m^3 equals 1 unit.

There are two key criteria to determine the sampling size:

1. The *heterogeneity or variation* of waste is to be determined by pre-investigation of the waste and stated as the *natural variation coefficient*.

2. The value of *relative accuracy* also plays a key role. The recommendation is 10% of random sampling error based on a 95% confidence level and under the assumption that the natural variation coefficient for household waste is about 30%.

The number of necessary samples, also called (sampling) units, can be calculated as follows (EC, 2004):

$$n = \left(\frac{t_{a;n-1} \cdot \mathrm{var}\,coeff\,(x_i)}{\varepsilon_{\theta,r}} \right)^2 \text{ for } f = \frac{n}{N} < 0.05$$

n:	number of sampling units
$t_{\alpha;n-1}$:	confidence coefficient (from tabulated- t-distribution with error probability α and n-1 degrees of freedom)
varcoeff(x_i):	variation coefficient of single values from the sample
ε_{Θ} ,r:	maximum allowance for random sampling error
Θ:	estimate value for the wanted parameter in the parent population
N:	number of survey units in the parent population
f:	sample proportion

While the relative accuracy has to be established with a view to the aim of accuracy for the waste analysis, the variation/ natural variation coefficient has to be determined via pre-investigation[135].

[135] EC, 2004

For the waste analyses in Khanty-Mansiysk, the confidence level is 95% with a statistical accuracy of between 10% and 15%. Based on the recommendations and experiences from ARGUS e.V., a natural variation coefficient of about 40 % for the mixed solid household and commercial waste can be assumed.

This results in the following calculation[136]:

$t_{\alpha;n-1}$: **1.960** - confidence coefficient (from tabulated- t-distribution with error probability α and n-1 degrees of freedom)
varcoeff(x_i): **40%** - variation coefficient of single values from the sample
ε_{Θ} ,r: **Between 10 % and 15 % (**arithmetic mean = 13 %)- maximum allowance for random sampling error

$$n = \left(\frac{1.960 \cdot 0.4}{0.13} \right)^2 \text{ for } f = \frac{n}{N} < 0.05 \rightarrow \mathbf{n = 36}$$

It is also recommended to analyse a minimum of 6 units per stratum as this guarantees a secured result. Furthermore, a matrix is recommended in order to show the ratio and therefore the importance of the single stratum. The sampling units were subdivided into the four strata (see table 10).

table 10: Number of sampling units

Strata residential structure/ strata	Number of sampling units
1. Small houses with a garden (1 floor)	6
2. Apartment blocks settlements (> 1 floor)	12
3. Commercial/ residential areas (apartment blocks > 1 floors)	12
4. Commercial areas	6
Total	**36**

In regard to the multi-stage random selection within the town Khanty-Mansiysk, four residential areas were determined for the stratum residential structure, as mentioned above. In the second stage, random streets within these areas were chosen, and in the third stage, containers/ **S**ampling **U**nits (SU) in these streets were randomly selected. 36 collection sites/ sampling units in total were selected (see figure 16).

[136] EC, 2004

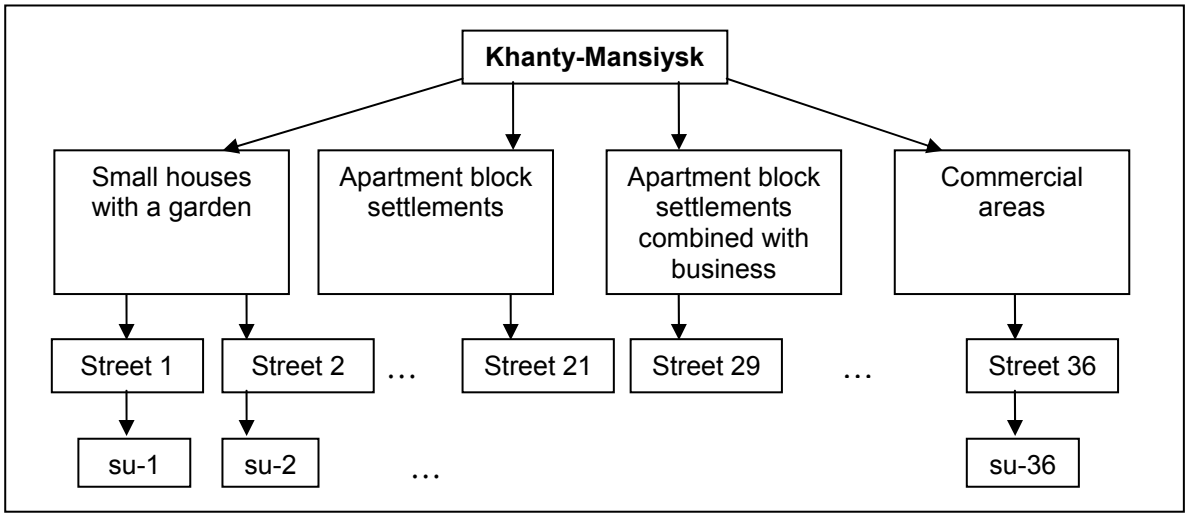


figure 16: Multi-stage random selection of sampling units

For the analysis in Khanty-Mansiysk the primary categories of the SWA-Tool sorting catalogue was used. In addition, the primary categories were extended by second categories to collect more detailed information as the waste analysis was the first one carried out in Khanty-Mansiysk. Eventually, 34 categories were used for the waste analysis in Khanty-Mansiysk (see Appendix 1 - List of waste catalogue).

4.3 Results of waste analysis

Based on the results of the waste analyses implemented in summer and winter (compare table 11 and table 12), the amount of municipal waste and waste composition generated per week and year was estimated. Mainly the results of the first waste category are shown in the table below; the complete results for the second category are given in *Appendix 2 - Detailed results of waste analysis*.

table 11: Results of sampling within the waste analysis in winter [kg w-1]

1st Category	No	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total Winter
Organics	1	246	358	309	110	1023
Wood	2	0	16	21	1	38
Paper/ Cardboard	3	20	109	137	71	336
Plastics	4	55	126	107	31	319
Glass	5	99	156	169	15	438
Textiles	6	6	14	8	1	29
Metals	7	23	37	23	6	88
Hazardous Waste	8	0	12	16	0	29
Composites	9	12	44	26	7	88
Other Categories	10	47	164	110	3	324
Fine fraction	11	35	79	49	14	177
Total		**544**	**1113**	**974**	**258**	**2,889**

table 12: Results of sampling within the waste analysis in summer [kg w-1]

1st Category	No	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total summer
Organics	1	144	274	196	168	782
Wood	2	20	74	10	15	119
Paper/ Cardboard	3	38	61	80	58	237
Plastics	4	63	99	87	84	333
Glass	5	53	107	91	37	289
Textiles	6	27	25	10	8	71
Metals	7	93	22	12	10	137
Hazardous Waste	8	2	1	1	0	4
Composites	9	15	30	48	7	100
Other Categories	10	47	163	68	24	302
Fine fraction	11	17	31	21	7	76
Total		**518**	**888**	**623**	**419**	**2,448**

Results of waste amount

Based on the results of sampling, seasonal results of waste amount generated in Khanty-Mansiysk can be estimated. According to the single strata, the seasonal results show the weekly waste amount in the strata “small house with a garden”, “apartment blocks” and “apartment blocks with business” produce more waste in winter time than in summer time. The stratum “business” shows an inverted result: in this stratum more waste is generated in summer than in winter. One reason is the significant higher amount of organic waste in the summer time than in the winter time. Within the analysis of the stratum “business”, the waste of hotels was included. It can be assumed that the hotels have more guests in the summer time and therefore, more organic waste is produced. The results demonstrate that the highest amount of waste can be expected to be generated in winter. Summer shows a decrease of solid municipal waste amount (see table 13 and table 14).

table 13: Calculated waste amount per stratum and per waste category for winter period [Mg w-1]

1st Category	No	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total Winter
Organics	1	53	68	39	28	189
Wood	2	0	3	3	0	6
Paper/ Cardboard	3	4	21	17	18	61
Plastics	4	12	24	14	8	58
Glass	5	21	30	22	4	76
Textiles	6	1	3	1	0	5
Metals	7	5	7	3	2	16
Hazardous Waste	8	0	2	2	0	4
Composites	9	3	8	3	2	16
Other Categories	10	10	31	14	1	56
Fine fraction	11	7	15	6	4	33
Total		**116**	**213**	**124**	**67**	**520**

table 14: Calculated waste amount per stratum and per waste category for summer period [Mg w-1]

1st Category	No	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total summer
Organics	1	31	52	25	44	152
Wood	2	4	14	1	4	23
Paper/ Cardboard	3	8	12	10	15	45
Plastics	4	13	19	11	22	65
Glass	5	11	20	12	10	53
Textiles	6	6	5	1	2	14
Metals	7	20	4	2	3	28
Hazardous Waste	8	0	0	0	0	1
Composites	9	3	6	6	2	17
Other Categories	10	10	31	9	6	56
Fine fraction	11	4	6	3	2	14
Total		**111**	**170**	**79**	**109**	**469**

On the basis of the seasonal results, the total annual amount of solid municipal waste in Khanty-Mansiysk was calculated as **25,785 Mg a^{-1}** (compare table 15). The stratum “apartment blocks” produces the highest amount of waste within all strata in Khanty-Mansiysk as there are the highest volume of containers in this strata (compare also *Chapter 4.2;* table *10: Number of sampling units*). That also means that this stratum has the most influence on the waste amount in Khanty-Mansiysk.

table 15: Calculated annual waste amount per stratum and per waste category [Mg/a-1]

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	1,916	2,877	1,386	1,727	7,906
	1-2	Biodegradable Garden/Park Waste	136	154	213	20	523
	1-3	Other Biodegradable Waste	128	118	79	129	454
Wood	2-1	Wood untreated	99	117	55	103	374
	2-2	Wood treated	15	332	46	0	394
Paper/ Cardboard	3-1	Non-biodegradable paper	8	53	60	41	163
	3-2	Paper/cardboard – packaging	164	394	303	342	1,203
	3-3	Paper/cardboard– non packaging	89	340	329	442	1,200
	3-4	Newspapers	61	59	28	45	193
Plastics	4-1	Plastic Film – packaging	256	403	242	452	1,354
	4-2	Plastic Film – non packaging	57	82	49	56	244
	4-3	Dense Plastic – packaging	254	516	299	185	1,254
	4-4	Dense Plastic – non packaging	93	119	53	86	350
Glass	5-1	Clear Glass Packaging	475	784	481	207	1,947
	5-2	Brown Glass Packaging	85	94	134	71	384
	5-3	Other Glass Packaging	189	360	228	74	850
	5-4	Miscellaneous Non Packaging Glass	101	71	20	1	193
Textiles	6-1	Clothes	113	120	46	38	317
	6-2	Non-clothing textiles	70	77	14	24	185
Metals	7-1	Ferrous Packaging	62	126	47	28	263
	7-2	Miscellaneous Ferrous	513	62	33	62	670
	7-3	Aluminium Packaging	36	91	30	16	172
	7-4	Miscellaneous Non-ferrous	35	17	5	0	57
Hazardous Waste	8-1	Batteries/Accumulators	2	3	3	1	9
	8-2	Miscellaneous hazardous waste	8	63	54	0	125
Composites	9-1	Composite Packaging	104	280	115	78	577
	9-2	Composite Non-packaging	31	34	6	11	81
	9-3	WEEE	17	54	123	7	201
Other Categories	10-1	Soil and Stones	2	206	72	106	386
	10-2	Other inert	271	793	307	13	1,385
	10-3	Nappies	150	316	117	28	611
	10-4	Health Care/Biological Wastes	10	27	23	6	66
	10-5	Miscellaneous Categories	96	286	73	26	480
Fine fraction	11-1	10mm sieved fraction	289	547	234	145	1,214
Total			**5,933**	**9,973**	**5,306**	**4,572**	**25,785**

Furthermore, the waste generated per capita can also be determined. (***Note:*** In this case/ calculation, the waste generated in the stratum "business" is not included as a subdivision of waste per capita in the stratum "business" is not possible.) The residents of small houses with gardens produce the highest amount in winter, followed by the stratum "apartment blocks with business". In contrast, in the summer time, the inhabitants of the stratum "apartment blocks with business" generated the highest amount of waste in the summer time.

The least amount per capita is generated by residents from apartment blocks in summer and in the winter time. However, as mentioned before, this stratum is the most influential one (based on the number of inhabitants and volume of waste container) and in total produces the most waste in Khanty-Mansiysk (see table 16 and table 17).

The seasonal results show that most of the waste was produced in winter. One reason is that the inhabitants of small houses with a garden generate a significant higher amount of organic waste in winter than in summer.

table 16: Waste amount per capita and week in winter [kg c-1 w-1]

1st Category	**No**	**Small houses with a garden**	**Apartment blocks**	**Apartment blocks + business**	**Total Winter**
Organic	1	2.6	1.7	2.3	2.1
Wood	2	0.0	0.1	0.2	0.1
Paper/ Cardboard	3	0.2	0.5	1.0	0.5
Plastics	4	0.6	0.6	0.8	0.6
Glass	5	1.1	0.7	1.2	0.9
Textiles	6	0.1	0.1	0.1	0.1
Metals	7	0.2	0.2	0.2	0.2
Hazardous Waste	8	0.0	0.1	0.1	0.1
Composites	9	0.1	0.2	0.2	0.2
Other Categories	10	0.5	0.8	0.8	0.7
Fine fraction	11	0.4	0.4	0.4	0.4
Total per week		**5.8**	**5.2**	**7.1**	**5.8**
Total per year [kg c^{-1} a^{-1}]		**303.7**	**273.3**	**372.0**	**303.1**

table 17: Waste amount per capita and week in summer [kg c^{-1} w^{-1}]

1st Category	No	Small houses with a garden	Apartment blocks	Apartment blocks + business	Total Summer
Organics	1	1.5	1.3	1.4	1.4
Wood	2	0.2	0.3	0.1	0.3
Paper/ Cardboard	3	0.4	0.3	0.6	0.4
Plastics	4	0.7	0.5	0.6	0.6
Glass	5	0.6	0.5	0.7	0.6
Textiles	6	0.3	0.1	0.1	0.2
Metals	7	1.0	0.1	0.1	0.3
Hazardous Waste	8	0.0	0.0	0.0	0.0
Composites	9	0.2	0.1	0.3	0.2
Other Categories	10	0.5	0.8	0.5	0.6
Fine fraction	11	0.2	0.1	0.2	0.2
Total per week		**5.6**	**4.2**	**4.6**	**4.6**
Total per year [kg c^{-1} a^{-1}]		**289.7**	**218.0**	**237.9**	**240.8**

The overall results demonstrate that for an inhabitant the average value of waste generation is 272.0 kg c^{-1} a^{-1} (see table 18).

table 18: Total waste amount per capita and year [kg c-1 a-1]

1st Category	No	Small houses with a garden	Apartment blocks	Apartment blocks + business	Total
Organic	1	109.0	77.6	96.4	89.8
Wood	2	5.7	11.1	5.8	8.5
Paper/ Cardboard	3	16.1	20.8	41.4	24.2
Plastics	4	33.0	27.6	37.0	31.1
Glass	5	42.5	32.2	49.6	38.7
Textiles	6	9.1	4.8	3.4	5.6
Metals	7	32.3	7.3	6.6	13.5
Hazardous Waste	8	0.5	1.6	3.2	1.7
Composites	9	7.6	9.1	14.0	9.8
Other Categories	10	26.4	40.1	34.0	35.2
Fine fraction	11	14.5	13.5	13.4	13.7
Total per year		**296.7**	**245.6**	**305.0**	**272.0**
Total per week [kg c^{-1} w^{-1}]		**5.7**	**4.7**	**5.8**	**5.2**

Comparison of results of SWA-Tool and measurement from M DEP regarding waste amount

The annual amount of waste calculated based on the SWA-Tool is 25,785 Mg a^{-1} (see table 15). In comparison, the result of the daily measurements of the municipal waste delivered to the landfill by the scales in front of the landfill in Khanty-Mansiysk is 29,125.6 Mg a^{-1}[137] per year (compare table 8). This figure also includes medical waste, bulky and demolition waste amongst others in contrast to the figure calculated via SWA-Tool.

However, the different figures calculated for annual amounts of municipal waste do not vary greatly; i.e. the calculation based on the SWA-Tool matches the measurement of the scales in the front of the landfill.

The monthly results of the measurements done by M DEP at the scales in front of the landfill demonstrate an increase of waste during the spring and summer period. For the months April and May the highest amount of waste was recorded (see table 19). In contrast to that, the waste analysis shows that more solid household waste is generated in the winter period than in the summer period. One reason for this different result can be the unknown amount of street cleaning and bulky waste. These waste streams are mainly generated in the summer time. The amount of these waste streams is estimated by M DEP and they are delivered to the landfill without any regular extra measurement via scales at the front of the landfill (compare table 8). The seasonal calculation of the SWA-Tool does not consider these waste streams as they are not part of the waste analysis. Therefore, a higher amount of solid municipal waste can be expected in the summer time but an increase of domestic waste can be anticipated in the wintertime.

table 19: Monthly measurements of municipal waste delivered to the landfill in Khanty-Mansiysk[138]

Companies	January	February	March	April	May	June	July	August	September	October	November	December	Total
M DEP	1,637.7	1,394.1	1,699.1	1,953.3	2,117.9	2,014.8	2,079.8	2,002.6	2,007.7	1,925.3	1,705.4	1,723.0	22,260.7
private companies	584.6	493.5	665.4	711.1	582.5	508.8	445.3	432.2	415.7	426.0	339.3	475.1	6,079.5
private persons	62.0	45.2	67.6	86.8	67.7	67.9	68.0	66.9	71.9	67.6	56.4	57.4	785.4
Total	2,284.3	1,932.8	2,432.1	2,751.2	2,768.1	2,591.5	2,593.1	2,501.7	2,495.3	2,418.9	2,101.1	2,255.5	29,125.6

Results of waste composition

The municipal waste in Khanty-Mansiysk shows ***annually*** comparable waste compositions within all strata (see figure 17). There are four main fractions:

- organics (kitchen),
- paper/cardboard
- plastics and,
- glass.

[137] Inozemcev, 2011d
[138] Inozemcev, 2011d

They comprise 70.7% of the total waste composition in Khanty-Mansiysk. Almost all other fractions (except fines) are under 5%. A complete subdivision of each second waste category is given in *Appendix 2 - Detailed results of waste analysis*.

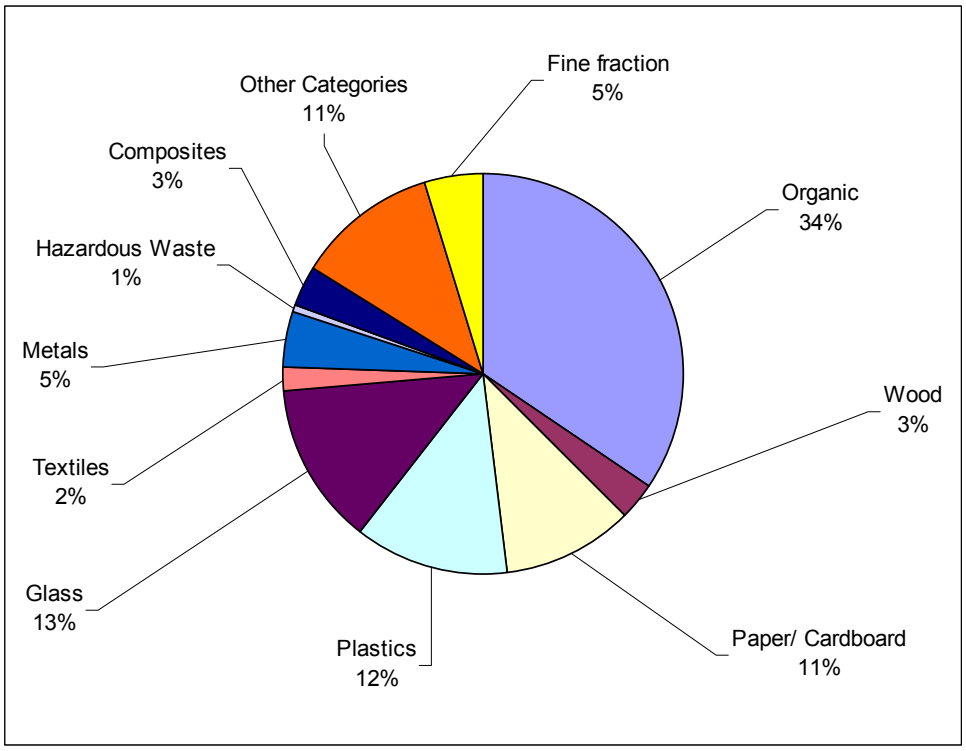


figure 17*: Annual waste composition of Khanty-Mansiysk*

Because of the subdivision of the residential structure in Khanty-Mansiysk into four *strata*, the annual averages of all four strata will also be analyzed in order to compare their commonalities and differences (see figure 18). The four main fractions, organics, paper/cardboard, plastics and glass comprise:

- 67.6% in the stratum “small houses with gardens”
- 64.4% in the stratum “apartment blocks”
- 73.6% in the stratum “apartment blocks and business” and
- 84.8% in the stratum “business.

There are significant differences between the waste compositions from all four residential structures/ strata:

More organic waste is produced in the stratum “business” than in the other strata.

In the stratum “business” the highest amount of cardboard/ paper and plastic is generated.

The proportion of glass is comparable in almost all four strata; except for the stratum “business” that produces less glass than the other strata.

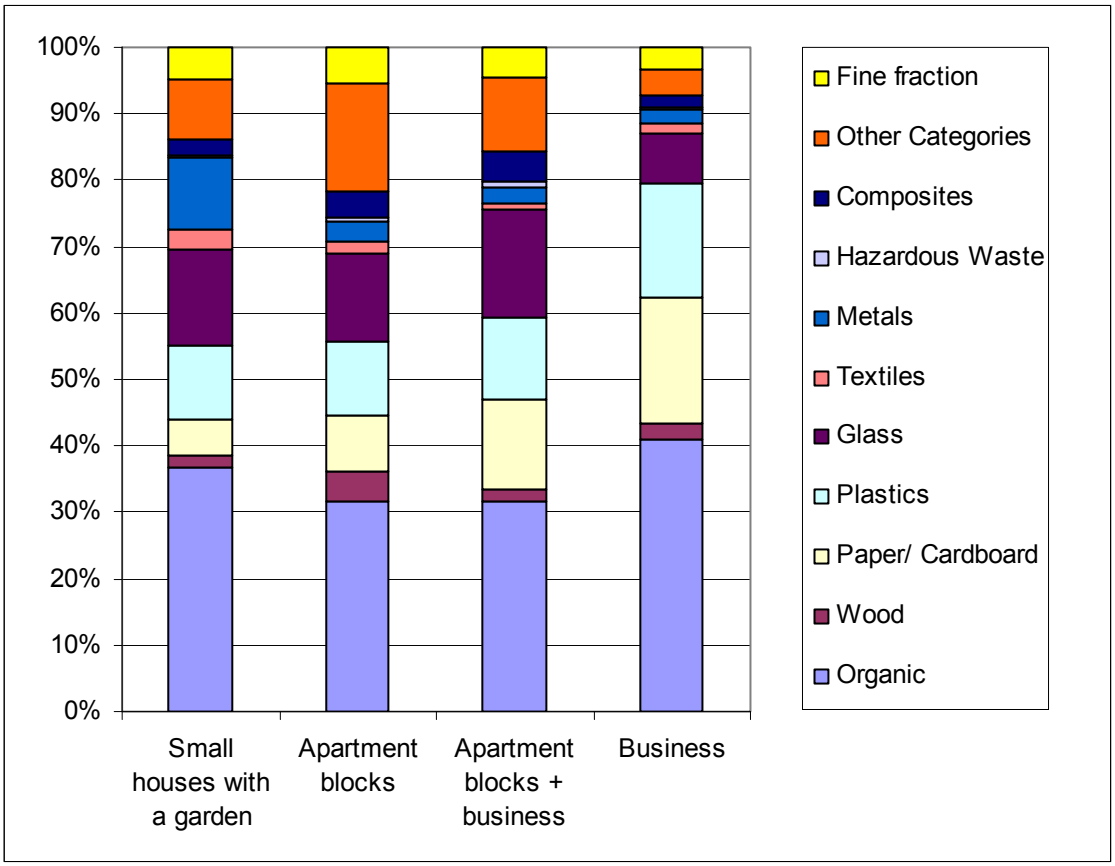


figure 18: Annual waste composition subdivided into the four strata in Khanty-Mansiysk

Although the waste as a whole shows a comparable composition between the four strata, a subdivision into ***seasons*** reveals differences in the four main fractions (see figure 19):

The strata “apartment blocks” and “apartment blocks with business” do not show significant changes between the analysis in summer and in winter.

The stratum “small houses with gardens” demonstrates differences between summer and winter in the waste categories “organics”, “glass” and “metal”. The organic proportion is less in summer than in winter time. It can be assumed that the organic waste will be treated in the garden in the summer time, in contrast to the winter time. In regard to the proportion of metal, it has to be mentioned that a lot of car parts were found during the waste analysis.

Within the stratum “business” the proportion of paper/cardboard fluctuates: in the winter time the proportion is higher than in the summer time.

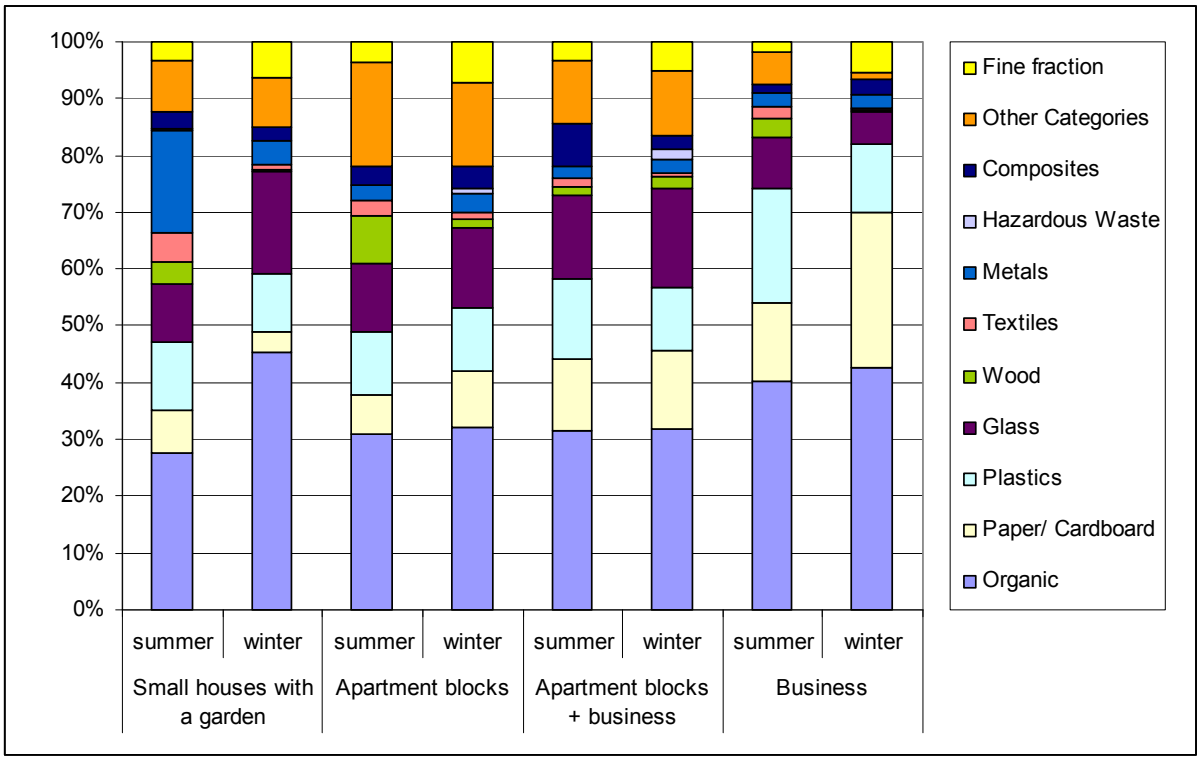


figure 19: Seasonal waste composition subdivided into the four strata in Khanty-Mansiysk

Furthermore, the annual waste composition of Khanty-Mansiysk is compared with the annual waste composition of Berlin, Russia and the EU. The aim is to identify similarities or differences. For similar waste compositions there is the possibility to fall back on existing and proved waste management concepts from others towns.

The detailed differences between the four towns and countries regarding the percentages of organic waste, plastics, glass, paper/cardboard are shown in figure 20.

The proportion of organic waste is quite similar in all cities; the waste composition of Berlin includes the highest percentage of organic waste; in the EU the lowest percentage of organic waste.

In contrast to that, the proportion of paper/cardboard is higher in Russia, Berlin, and the EU than in Khanty-Mansiysk.

The proportions of lightweight packaging (combination of plastic and metal waste) and glass are higher in Khanty-Mansiysk than in Berlin, Russia and EU.

The proportions of all other waste streams are quite similar in all towns and countries.

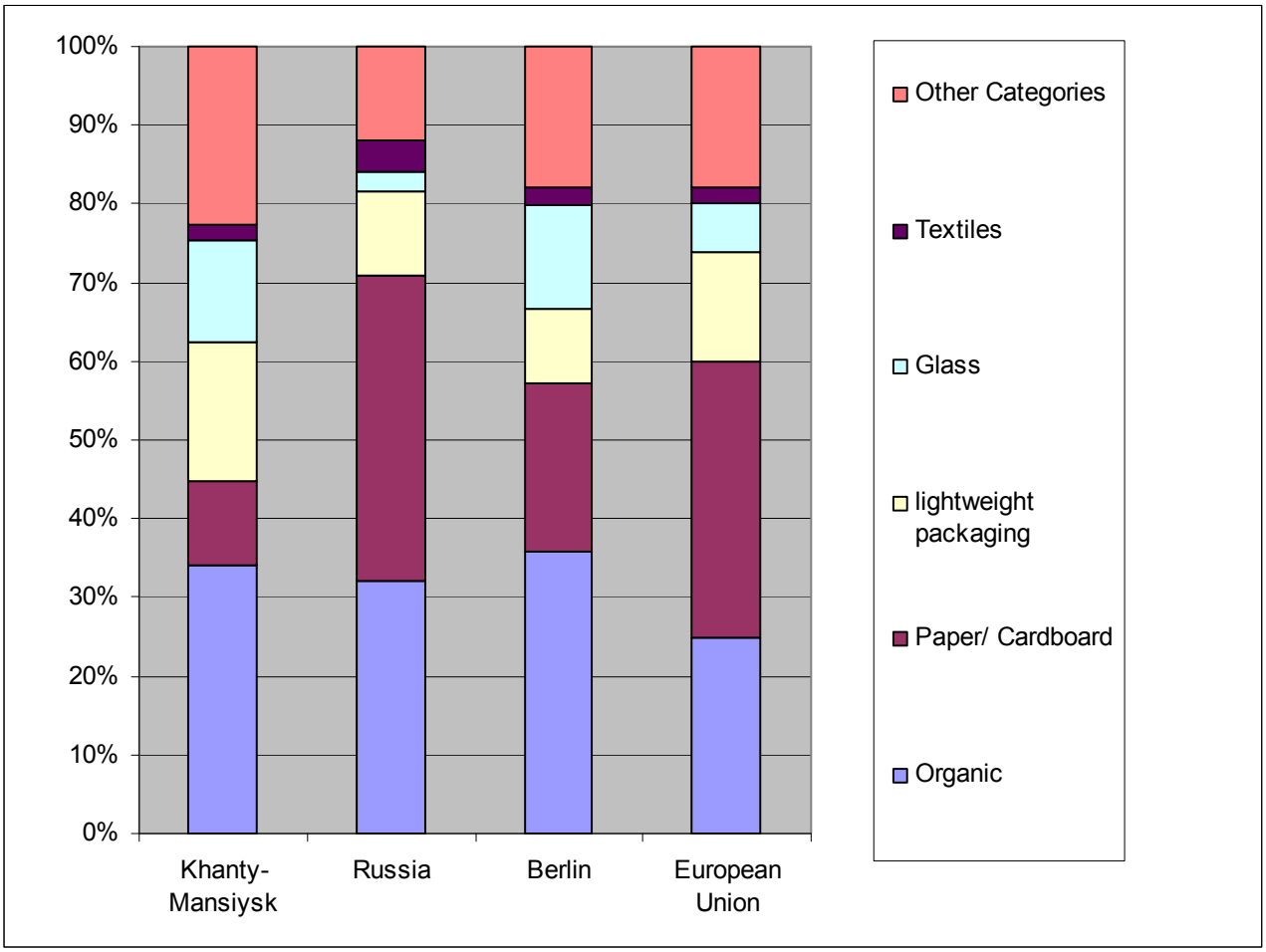


figure 20: Comparison of waste composition among Khanty-Mansiysk, Berlin, Russia and the European Union

Finally, for developing the urban waste management concept in Khanty-Mansiysk, the following results of the waste analyses have to be taken into consideration:

More solid domestic waste is generated in the winter time than in the summer time, but a higher amount of municipal waste can be expected in the spring and summer period.

More organic waste can be expected in the winter time than in the summer time.

The four main fractions (organic, cardboard/paper, plastic and glass) compromise more than 70% of the waste. These fractions are also very suitable for recycling.

Although the residents of the stratum “apartment houses” produce the fewest amount of waste per capita, they produce the highest amount in total – as this stratum is the biggest stratum within the four strata developed for Khanty-Mansiysk.

The seasonal results of the strata “apartment blocks” and “apartment blocks with business” do not show differences among the seasons in contrast to the results of the strata “small houses with a garden” and “business”. Especially the fractions “organic”, metal and cardboard/paper show seasonal fluctuations.

Although there are differences between the waste composition from Khanty-Mansiysk and the sample towns and countries/ case studies, there are also similarities. Mechanical-biological and/or mechanical-physical treatment plants have proven to be optimal for treating municipal waste with

such a waste composition in Berlin and the EU. Therefore, this type of treatment plants should be considered during the development of a sustainable waste management concept for Khanty-Mansiysk.

4.4 Results of water content analysis

The water content of waste is an essential factor, i.e. the water content influences the ability of compost or flammability of the waste. The heating value indicates the amount of energy per kilogram waste through incineration. Decreasing heating value and increasing water content cause to low temperature within the incineration plant. The heating value also determines the capacity of the incineration plant.

Based on the single results of each water content analysis in summer and in winter, 40.6% of average water content could be calculated for the solid municipal waste in Khanty-Mansiysk. The results also show that in the winter the water content of the waste is higher than in the summer time. On reason could be the open waste containers as the snow can come in contact with the waste.

The average heating value is 6,958KJ/kg based on the water content aforementioned (see table 20).

table 20: Average water content and heating value of municipal waste analysed in Khanty-Mansiysk[139]

1st Category	No	Composition [%]	Water content [%]	Hydrogen content [%]	Calorific value Ho(wf) [KJ/kg]	Heating value Hu(roh) [KJ/kg]
Organic	1	34	68.7	3.76[1]	13,580[1]	2,315
Wood	2	3	27.7	6.8[3]	20,630[3]	13,159
Paper/ Cardboard	3	11	14.9	5.12[1]	16,290[1]	12,542
Plastics	4	12	29.9	14.5[3]	38,580[3]	24,082
Glass	5	13	2.0	0.0	0	-49
Textiles	6	2	27.0	6.4[3]	19,900[3]	12,842
Metals	7	5	11.9	0.0%	0	-290
Hazardous Waste	8	1	9.9	0.0%	0	-242
Composites	9	3	12.9	9.8[2]	27,435[2]	21,704
Other Categories	10	11	61.8	1.4[1]	14,000[2]	3,723
Fine fraction	11	5	43.5	1.8	8,000[2]	3,235
Total		**100**	**40.6**	**4.53%**	**15,073**	**6,958**

For the development of the urban waste management concept, the lower heating value has to be considered. In order to reach a optimal amount of energy, a back-up fire is necessary. Furthermore, a change of the heating value is to be expected through implementation of recycling, especially through recycling of plastics and paper/ cardboard. A decrease of the heating value is to

[139] [1] - Greiner, et al., 1983; [2] – ARGUS e.V., experienced data; [3] - Bilitewski, et al., 1990

be assumed. In contrast to that, recycling of glass and organics increases the heating value[140]. Therefore, the current exiting heating value does not prove an optimal thermal process.

4.5 Waste prognosis

The successful planning of a sustainable waste management concept depends on the prediction accuracy of solid waste generation. Therefore, the prognosis of waste quality and quantity is one of the most important tasks in developing a waste management concept but also the most problematic issue. Prognoses are essential for selecting a suitable type of future waste disposal, for the size of waste treatment plants as well as for the decision of utilisation of waste such as recycling. Several factors influence waste amount and quality, but these factors which include population growth, employment, environmental awareness and policies are also difficult to predict. Additionally, if there are no historical data the process of prognosis will be even more complicated.

The figures given by the local authorities and the figures calculated via SWA-Tool are the basis for the waste prognosis. Factors which have an influence of the waste prognosis are:

- positive development of population until 2014
- an increase of GDP of the region KMAO-Ugra and average income of inhabitants in Khanty-Mansiysk until 2024
- current waste amount and waste composition in Khanty-Mansiysk in 2010.

The waste prognosis is prepared for the short, medium and long term future. Therefore, the forecasted waste composition and amount is to be considered until 2024 given for two-years-interval. Furthermore, the prognosis is developed for different waste streams such as household waste including commercial waste as well as bulky waste etc.

A subdivision of the waste amount and composition forecasted according to the strata is not implemented. There is no information about the future development of the single strata such as the development of number of inhabitants per strata. Therefore, a waste prognosis per strata is not feasible.

The results of the prognosis are very important especially for the single waste streams which are very suitable for the reduction of the volume of municipal waste such as organics, plastics, paper/cardboard and glass.

Forecasting waste amount in Khanty-Mansiysk until 2024

According to the calculations done by ARGUS e.V., solid household waste generation including commercial waste will increase from 25.785 Mg a^{-1} in 2010 to 49,120 Mg a^{-1} in 2024 in Khanty-Mansiysk; i.e. the amount of household waste including commercial waste, will be doubled in the next 14 years. Furthermore, it can be also expected that the amount of bulky waste, construction and demolition waste, street cleaning waste, veterinary waste, and end-of-life tyres will increase (see table 21).

[140] Cord-Landwehr, 2002

table 21: Prognosis of municipal waste until 2024 [Mg a^{-1}]

Waste types	2010	2012	2014	2016	2018	2020	2022	2024
Household Waste & Commercial Waste	25,785	28,737	32,028	35,351	39,019	43,068	46,618	50,461
Household Waste	*21,917*	*24,427*	*27,224*	*30,048*	*33,166*	*36,608*	*39,625*	*42,892*
Commercial Waste (similar to household waste)	*3,868*	*4,311*	*4,804*	*5,303*	*5,853*	*6,460*	*6,993*	*7,569*
Bulky waste & construction & demolition waste	3,410	3,800	4,236	4,675	5,160	5,696	6,165	6,673
Sum of other waste types	1,922	2,142	2,387	2,635	2,908	3,210	3,474	3,761
Medical waste	*180*	*201*	*224*	*247*	*272*	*301*	*325*	*352*
Street cleaning residues and waste from litter bins, Garden and park waste, market waste	*1,428*	*1,592*	*1,774*	*1,958*	*2,161*	*2,385*	*2,582*	*2,795*
Veterinary medicine waste	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
End-of-life tyres	*313*	*349*	*389*	*429*	*474*	*523*	*566*	*613*
Total	**31,117**	**34,680**	**38,650**	**42,661**	**47,087**	**51,973**	**56,257**	**60,895**

Forecasting waste composition in Khanty-Mansiysk until 2024

In regard to estimating the quality of the household waste, including commercial waste (similar to household waste), the results of the prognosis show the percentages of the different waste proportions such as organics and plastics. The forecasted waste compositions for 2024 are comparable to those analysed in 2010 (see table 22 and table 23). Solid household waste mainly consists of organics, plastics, glass and paper/cardboard.

table 22: Forecasted waste amount of 1st category for Khanty-Mansiysk [Mg a^{-1}]

1st Category	2010	2012	2014	2016	2018	2020	2022	2024
Organic	8,882	9,899	11,033	12,177	13,441	14,836	16,059	17,382
Wood	768	856	954	1,053	1,162	1,283	1,389	1,503
Paper/ Cardboard	2,759	3,074	3,427	3,782	4,174	4,608	4,987	5,399
Plastics	3,202	3,569	3,977	4,390	4,845	5,348	5,789	6,266
Glass	3,375	3,761	4,192	4,627	5,107	5,637	6,101	6,604
Textiles	502	559	623	688	759	838	907	982
Metals	1,162	1,295	1,444	1,593	1,759	1,941	2,101	2,274
Hazardous Waste	134	150	167	184	203	224	243	263
Composites	860	958	1,068	1,178	1,301	1,436	1,554	1,682
Other Categories	2,927	3,262	3,636	4,013	4,430	4,889	5,292	5,729
Fine fraction	1,214	1,353	1,508	1,665	1,838	2,028	2,195	2,376
Total	**25,785**	**28,737**	**32,028**	**35,351**	**39,019**	**43,068**	**46,618**	**50,461**

table 23: Forecasted waste amount of 2nd category for Khanty-Mansiysk [Mg a-1]

1st Category	No	2nd Category	2010	2012	2014	2016	2018	2020	2022	2024
Organics	1-1	Biodegradable Kitchen/ Canteen Waste	7,906	8,811	9,820	10,839	11,964	13,205	14,294	15,472
	1-2	Biodegradable Garden/Park Waste	523	582	649	716	791	873	945	1,023
	1-3	Other Biodegradable Waste	454	506	564	622	687	758	820	888
Wood	2-1	Wood untreated	374	417	465	513	567	626	677	733
	2-2	Wood treated	394	439	489	540	596	657	712	770
Paper/ Card-board	3-1	Non-biodegradable paper	163	182	202	223	247	272	295	319
	3-2	Paper/cardboard – packaging	1,203	1,341	1,494	1,649	1,820	2,009	2,175	2,354
	3-3	Paper/cardboard - non packaging	1,200	1,338	1,491	1,645	1,816	2,004	2,170	2,349
	3-4	Newspapers	193	215	239	264	292	322	348	377
Plastics	4-1	Plastic Film – packaging	1,354	1,508	1,681	1,856	2,048	2,261	2,447	2,649
	4-2	Plastic Film – non packaging	244	272	303	334	369	407	441	477
	4-3	Dense Plastic – packaging	1,254	1,398	1,558	1,720	1,898	2,095	2,268	2,455
	4-4	Dense Plastic – non packaging	350	390	435	480	530	585	633	685
Glass	5-1	Clear Glass Packaging	1,947	2,170	2,419	2,670	2,947	3,253	3,521	3,811
	5-2	Brown Glass Packaging	384	428	477	526	581	641	694	751
	5-3	Other Glass Packaging	850	948	1,056	1,166	1,287	1,421	1,538	1,664
	5-4	Miscellaneous Non Packaging Glass	193	215	240	265	292	323	349	378
Textiles	6-1	Clothes	317	353	394	434	479	529	573	620
	6-2	Non-clothing textiles	185	206	230	253	280	309	334	362
Metals	7-1	Ferrous Packaging	263	294	327	361	399	440	476	515
	7-2	Miscellaneous Ferrous	670	747	833	919	1,014	1,120	1,212	1,312
	7-3	Aluminium Packaging	172	192	213	236	260	287	311	336
	7-4	Miscellaneous	57	63	70	78	86	95	102	111

1st Category	No	2nd Category	2010	2012	2014	2016	2018	2020	2022	2024
		Non-ferrous								
Hazar-dous Waste	8-1	Batteries/Accumulators	9	10	11	13	14	15	17	18
	8-2	Miscellaneous hazardous waste	125	139	155	171	189	209	226	245
Compo-sites	9-1	Composite Packaging	577	643	717	791	873	963	1,043	1,129
	9-2	Composite Non-packaging	81	91	101	111	123	136	147	159
	9-3	WEEE	201	225	250	276	305	336	364	394
Other Cate-gories	10-1	Soil and Stones	386	430	479	529	584	644	697	755
	10-2	Other inert	1,385	1,543	1,720	1,898	2,095	2,313	2,503	2,710
	10-3	Nappies	611	681	759	838	925	1,021	1,105	1,196
	10-4	Health Care/Biological Wastes	66	74	82	90	100	110	119	129
	10-5	Miscellaneous Categories	480	535	596	658	726	802	868	939
Fine fraction	11-1	10mm sieved fraction	1,214	1,353	1,508	1,665	1,838	2,028	2,195	2,376
Total			**25,785**	**28,737**	**32,028**	**35,351**	**39,019**	**43,068**	**46,618**	**50,461**

For the preparation of the waste management concept for Khanty-Mansiysk, an increase of the waste amount has to be taken into consideration, especially an increase of organic waste. In contrast to that, a sudden change of the waste composition is not to be expected. However, an increase of electronic waste can be anticipated as currently the amount of electronic waste is increasing worldwide.

That means the future urban waste management concept has to deal with almost double the amount of waste in comparison with the current situation.

A reduction of the waste amount, for example through recycling, reduces the amount of municipal waste – which is the aim of the sustainable urban waste management concept in Khanty-Mansiysk. In 2024, there are still 70% of very suitable waste streams for recycling such as organic, plastic, cardboard/paper and glass waste. Therefore, waste recycling strategies seem to be optimal solutions for the waste management in Khanty-Mansiysk.

5. Market analysis

The implementation of a new waste management concept is connected with costs and there are different possibilities to cover the costs. Therefore, the aims of the market analysis were to determine whether there is currently a recycling market in KMAO-Ugra and/ or Russia as well as to identify whether materials from the solid municipal waste generated in Khanty-Mansiysk have a market value; i.e. if selling them can financially support the implementation of the new waste management concept.

5.1 Methodology

For the market analysis three types of companies were identified which play an essential role for waste recycling:

- Companies which collect and/ or treat materials recovered from solid municipal waste such as recycling companies
- Factories which use materials from waste in order to produce new products such as a glass manufacturing company and
- Transport companies for transport of waste.

In order to implement the market analysis, contact data of recycling companies had to be collected. For identifying these contact addresses the “German Trade and Invest”, the “Russian Chamber of Commercial and Industry”, “Territorial institution of the federal office for state statistic in KMAO-Ugra” and “Territorial Management of Federal Service for supervision in the sphere of nature management in KMAO-Ugra (Rosprirodnazor)” were contacted. Furthermore, internet researches were carried out.

The “German Trade and Invest” does not have contact data of recycling companies in KMAO-Ugra and referred to the “Russian Chamber of Commercial and Industry”[141]. There exists a list of almost 140 Russian companies in KMAO-Ugra; none of these companies works in the waste disposal and/or treatment area. It has to be mentioned that the registration on this list is voluntary and does not reflect the entire situation of existing companies in KMAO-Ugra.

The list of all companies in KMAO-Ugra given by the “Territorial institution of the federal office for state statistic in KMAO-Ugra” is available on the internet and includes more than 40.000 companies in KMAO-Ugra[142]. This list was also checked in order to find out contact data of recycling companies.

As “Rosprirodnazor” awards the licence for waste disposal and/or treatment, a list of all companies operating in the waste sector was requested. The list includes 59 companies and starts in 2010[143]. At the moment the list is being reviewed and all companies with a licence will be registered in this list soon[144]. Furthermore, this list does not include contact data such as a telephone number and/or e-mail address.

[141] Germany Trade and Invest GmbH, 2011
[142] Territorial institution of the federal office for state statistic in KMAO-Ugra, 2011
[143] Kiseleva, 2011a
[144] Kiseleva, 2011b, interview

All telephone numbers and e-mail addresses were researched via internet.
For implementing the market analysis, the recycling companies were called at first and asked to fill in a questionnaire and send it back via e-mail or fax. A deadline was given and on the day of the deadline a reminder e-mail/ fax was send.

The same procedure for implementing the market analysis was applied to recycling companies in Irkutsk, Perm and Yekaterinburg. The contact data of companies in Irkutsk was acquired from the "calendar of waste" (a booklet of recycling companies in Irkutsk) developed within the project "Development of a Waste Management Concept for the Tourist Regions of Lake Baikal"[145].

The contact data of companies from Perm were obtained from the branch book "Yellow pages - 2010"[146] and the contact data of companies in Yekaterinburg were provided by the Perm State University[147]. The Perm State University is currently in the process of initiating a co-operation among all waste disposal/ treatment companies in Yekaterinburg and therefore has this information.

In addition, to identify transport companies and factories, only the list of the "Territorial institution of the federal office for state statistic in KMAO-Ugra"[148] could be used. Transport and manufacturing companies such as glass and metal were only researched in KMAO-Ugra.

During the implementation of the market analysis, it became apparent that not a good response was to be expected. Therefore, an expert questionnaire was developed and given to waste experts in Nischnivartovsk, Perm, Irkutsk and Khanty-Mansiysk.

5.2 Results

Although, there are many lists about recycling companies, finding out the contact data was very problematic. Mainly there are very small companies and the private address of the company founder was named and websites of companies hardly exist. Additionally, many telephone numbers and e-mails addresses did not work although there were more than four telephone numbers for one company in some cases.

The questionnaire response from the recycling companies was not very satisfactory in all four investigation areas: KMAO-Ugra, Irkutsk, Perm and Yekaterinburg.

There were no answers from Perm (7 companies were contacted) and Yekaterinburg (16 companies were contacted).

In total, 26 companies were contacted in Irkutsk. One company "Mitugin" which collects transports and treats end-of life tyres, polymer products and several more recyclable materials responded from Irkutsk. They mainly operate in the region around Irkutsk and; produce approximately 25Mg materials from the (recyclable) waste they collect. Information about what exactly they produce was not provided[149].

The main emphasis for the market analysis in the investigation area KMAO-Ugra was on the companies which are written on the list given by "Rosprirodnazor" as there was the information that these companies have a licence for disposal/ treatment of waste. In total, 26 contact data of 59 companies mentioned in the list of "Rosprirodnazor" could be identified via internet.

[145] Ulanova, 2011
[146] Yellow pages, Perm, 2010
[147] Slyusar, 2011a
[148] Territorial institution of the federal office for state statistic in KMAO-Ugra, 2011
[149] Mitugin, 2011

Only four companies replied to the questionnaires from different towns in KMAO-Ugra. Two companies responded that they do not have anything to do with waste disposal and/or recycling. However, two companies which deal with recyclable materials answered, namely “Ekobalance” from Khanty-Mansiysk and “«Vtortschermet» from Surgut.

The first one collects cardboard and paper in Khanty-Mansiysk and transports the material to Perm, Yekaterinburg for recycling, mostly for toilet paper and tissues. Several dozen Mg of paper/ cardboard are collected per month (a detailed number of Mg can not be given caused by data protection). The standard “GOST 10700-97” has to be taken into account for collecting carton and paper for a further treatment[150].

The second company, „Vtortschermet”, treats used metal and transports it to metal factories all over Russia. Approximately two thousand Mg per year are treated according to the standard “GOST 5787” [151].
According to the research of manufacturing companies, it has to be said that again many telephone numbers and e-mail addresses did not work. It was researched for companies which produce metals, glass, tyres. These types of materials were chosen as the research of recycling companies demonstrated that primarily tyres and metals are collected from the solid municipal waste. The list of the “Statistical Office” offers many metal producing and three glass producing companies and one making tyres. In total, more than 20 companies were tried to be contacted. However, only one company for metal production and only one glass manufacturer could be called. All other telephone numbers did not work; although the telephone numbers were researched in the internet again.

The glass factory “Fabrikant” is located in Surgut and uses approximately 4.800m^2 raw glass per month to produce 1.600m^2 of glass for windows and other glass products. They have an interest to use recycled glass but it must be of good quality. A standard could not be given[152].

The metal-producing factory “Metallexpo” is also situated in Surgut. They already use metal from the solid municipal and industrial waste. Figures how many Mg of metal they take out of the waste or need or how many Mg of metal they produce per month/years were not provided[153].

Transport companies could not be identified during the research for the market analysis. Many companies which collect the material from the waste also transport the waste to the treatment plant/ factory – compare the companies “Ekobalance” from Khanty-Mansiysk and “Mitugin” from Irkutsk.
According to answers of the waste experts the recycling market in KMAO-Ugra is more or less determined by the (very) small companies. At the moment, there are hardly figures to estimate the quota of the recycling market in detail[154]. Approximately, 1-2% recycling of solid municipal waste can be estimated currently, mainly the materials “metal” and “cardboard/ paper” from the solid municipal waste[155].

1% as recycling quota of the solid household waste is estimated for the Irkutsk region. Mainly glass, cardboard/paper, metals and end-of-life tyres are recycled[156].

2-3% as recycling quota is estimated for the region of Perm; mainly metal, glass and cardboard/paper is used for recycling[157].

[150] Ilchuzhin, 2011
[151] Vtortschermet, 2011
[152] Fabrikant, 2011, interview
[153] Metallexpo, 2011, interview
[154] Vaschenko, 2011, interview
[155] Zubaydullin, 2011
[156] Ulanova, 2011a

5.3 Evaluation

Although the market analysis does not provide quantitative results it provides other information that is valuable for the development of an urban waste management concept for the town Khanty-Mansiysk:

There are already companies which collect different materials from of the waste; mostly cardboard, metal and end-of-life tyres.

The current quota of recycling is very small; only few and small companies exist to carry out the collection of different waste streams. However, these companies are also very interested in developing this branch. There is an interest of manufacturing companies to obtain recyclable materials as a resource for making their products.

The regional administration and the High Technology Park have an interest in establishing a recycling market and support the development with their resources. The Department of Ecology of KMAO-Ugra estimated that recycling can be built up to 15%. The main emphasis is on glass, plastic and cardboard.

At the moment there is no waste treatment facility in KMAO-Ugra – except a company treating metals in Surgut. Nevertheless, the High Technology Park was asked by investor to support the implementation of a sorting plant in Surgut and different requests from investors for investment into waste treatment facilities to the Department of Ecology. Furthermore, there are plans to build a treatment facility for end-of-life tyres close to Surgut. That also demonstrates that there is an interest in developing the recycling market.

That also means that Surgut has to be considered as a recycling centre during the development of the waste management concept for Khanty-Mansiysk. Surgut is 250 km far away from Khanty-Mansiysk; i.e. long distances between Khanty-Mansiysk and Surgut have to be taken into account.

Because Khanty-Mansiysk is an administrational town there is a high potential for cardboard and paper recycling. According to Mr Ilchuzhin[158], a lot of papers produced by the administration are burnt for data protection reasons. However, a systematic collection of cardboard is desirable.

In Khanty-Mansiysk, there are three companies which collect recyclable materials from waste: “Ekobalance” – which collects cardboard and “Akkumulatornoi Dom” – which collects metal and “Berejosow” – which collects end-of life tyres. At the moment there are no detailed data for the latter both companies. However, for the presentation of the waste management strategies in Khanty-Mansiysk in September 2011 all three companies should be invited for a thorough discussion about further development of a organised collection system for cardboard, metal and end-of-life tyres.

[157] Slyusar, 2011c
[158] Ilchuzhin, 2011

6. Waste management policy and legislation in Russia and Khanty-Mansiysk Autonomous Okrug - Ugra

The development of a waste management concept for the town Khanty-Mansiysk depends on the requirements that are given by Russian legislation. Regarding waste legislation, the main questions for developing an urban waste management concept raised here are:

- What are the objectives of waste legislation and what is the relevant legislation on federal level In Russia and in KMAO-Ugra?
- Which terms, definitions, classification and standards exist to describe the different waste streams?
- Who is authorized to collect the waste and who is the waste holder?
- What kind of fee system exists; i.e. who has to pay for what?
- Which are the competent authorities to develop and work on (urban) waste management concepts on federal and local level?

In the Russian Federation, there are different types of regulations for implementing governmental duties including waste management. Therefore, the legal and regulatory framework (also for the management of waste) is set out by:

- The Constitution of the Russian Federation
- Codes
- Federal laws (FL) and other normative legal acts of the Russian Federation as well as international agreements ratified by the Russian Federation and therefore, transferred to federal laws
- Policy directives of the Government of the Russian Federation,
- Resolution of the Government of the Russian Federation
- Technical regulations (GOST (state standards), OSTy (industrial standard), TU (technical specifications))
- Sanitary norms and rules (SanPiN)
- Building norms (Construction regulations (building codes), TSNy (territorial building codes))
- Instructions (The instructions of the Russian Federation, municipal instructions, instructions of enterprises)
- Recommendations (recommendations, acting in the entity of the Russian Federation, municipal recommendations)
- Methodological guidelines (guidelines for a Russian Federation subject, guidance on the territory of the municipality)

- Legislative and normative acts of subjects (administrative region of the Russian Federation such as KMAO-Ugra)
- resolutions of state power of subjects of the Russian Federation, Regulations of local governments and authorities
- Municipal normative and legal acts
- Departmental rules and regulations.

The key legal and regulatory framework for implementing waste management will be described in the next chapters.

6.1 Objectives of the waste legislation

Besides providing hygienic conditions in towns and settlements (compare SanPiN 42-128-4690-88 "Sanitary Regulations for the content of populated areas", from 05.August 1988) environmental protection is main objective for dealing with waste within the Russian legislation.

For that reason, the Constitution of the Russian Federation, from 12.December 1993 (last update 30. December 2008), according to article 42, includes that each person has the right of an intact environment, the right of information about the current condition of the environment as well as the right of compensation if there are law violations which cause problems with health or properties.

The "Federal Law (FL) on industrial and municipal waste" from 24.June 1998 No. 89 (last update 30. December 2008, No. 309-FL) describes the objectives of the Russia waste legislation and corresponds with the key act regarding waste management in Russia.

The law defines the legal basis of dealing with industrial and municipal waste in Russia. The major aims of this law is to prevent negative impacts on the health of humans and the environment caused by wrong waste disposal as well as implementing the recycling of materials from waste as a source for commodities and economic revenues.

To detail the major aims, the law also establishes the principles of state policy in the field of waste management:

Protecting human health, maintaining or restoring the health of the environment and the conservation of biological diversity

Scientifically based combination of environmental and economic interests in order to ensure a sustainable development of the society

Use of the latest scientific and technological achievements in order to realise low and non-waste technologies

Research of an optimal use of natural resources in order to reduce waste during the production process

Use of methods to regulate economic activities in the field of waste management in order to reduce waste and for economic progress

Allowing access to waste management information in accordance with the laws of the Russian Federation

Participation in international co-operation in the field of waste management.

This Federal law does not only state the key objectives for waste management in the Russian Federation, it describes the disposal, the responsibilities, the fee system etc; i.e. the implementing of waste management.

6.2 Relevant legislation for implementing waste management

The key law regarding waste management is the "Federal Law on industrial and municipal waste" from June 24, 1998 No. 89 (last update 30. December 2008, N 309-FL) also defines municipal and industrial waste, its classification and cadastre, the waste holder (which are described in *Chapter 6.3 Definition of waste and waste holder, waste classification as well as waste cadastre*) as well as the handling of waste which is described in the next paragraphs.

The law describes the power of administrative units in Article 8; small settlements are only responsible for the transport and collection of waste; communal districts are responsible for recycling and disposal and the urban districts (including towns) are responsible for collection, transport, recycling and disposal. So, local administrations have to contract a licensed company. (Note: A change of this rule is coming soon; see *Chapter 6.8 Future development of waste legislation in Russia and of waste management in Khanty-Mansiysk Autonomous Okrug - Ugra*).

The law includes the possibility of organising separate collection, including the procedure of collecting waste on the municipality level and provides for their division into types (food waste, textiles, paper, etc.). A separate collection has to be implemented by local authorities and must comply with environmental, sanitary and other requirements in the field of environment and human health.

Furthermore, the law gives recommendations for neutralising (hazardous) waste, the structure of the operation of the company and controlling the site. Furthermore, it requires that for getting a licence for operating a waste treatment plant (including a landfill) the operator has to prove that the employees are adequately skilled and certified for working with waste classified from I to IV.

Finally, it also declares that the transboundary import of waste for neutralisation and disposal is prohibited and that waste has to be reduced and used for economic benefits.

Beside the "Federal Law on industrial and municipal waste" from June 24, 1998 No. 89 (last update 30. December 2008, N 309-FL), different federal laws exist that deal with waste management:

- “Federal Law on the Protection of the Environment”, from 10. January 2002, N 7-FS
- “Federal Law on the sanitary-epidemiological welfare of the population, from 30 March 1999, No 52-FL (last update 28.September 2010, No.243-FL)
- “Federal Law of the subsoil”, 21. February 1992, N 2395-1 (last update 26. June 2010 N 186-FL)
- “Federal Law on Licensing Certain Types of Activities", 8. August 2001, N 128-FL (last update 4.May 2011, N 99)

- “Federal Law on the protection of atmospheric air”, from 22.April 1999, N 96-FL.

The ”Federal Law on the Protection of the Environment”, from 10. January 2002, N 7-FS supports the "Federal Law on industrial and municipal waste" from June 24, 1998 No. 89 (last update 30.December 2008, N 309-FL) in certain issues regarding waste disposal. In particular, Art. 51 of that law imposes the requirement for environmental safety of waste management facilities for industrial and municipal waste, i.e., the conditions and methods of collection, use, disposal, transportation, storage and disposal of industrial and municipal waste, including radioactive waste have to be safe for the environment.

In addition, the law prohibits:

- the disposal of sewage waste without treatment and radioactive waste on surface and underground water, water harvesting, in the subsoil and the soil,

- the disposal of hazardous wastes and radioactive wastes in areas adjacent to urban and rural settlements, in parks, in therapeutic and recreational areas, migration routes of animals, near spawning grounds and other places where the disposal could cause a danger to the environment, the ecological systems and human health,

- the disposal of hazardous waste and radioactive waste in the catchment area of underground water bodies used as sources of water in balneology purposes for the extraction of valuable mineral resources and

- the import of hazardous wastes and radioactive wastes into the Russian Federation in respect to their disposal and decontamination.

The “Federal Law on the sanitary-epidemiological welfare of the population, from 30 March 1999, No 52-FL (last update 28.September 2010, No.243-FL) in Art. 1922 establishes sanitary-epidemiological requirements on the collection, use, disposal, transportation, storage and disposal of industrial and municipal waste, declaring mandatory security conditions and how to implement these conditions.

“Federal Law of the subsoil”, from 21. February 1992, N 2395-1 (last update 26. June 2010 N 186-FL) regulates the connection between geological research and use and protection of the subsoil as well as the waste disposal.

The ""Federal Law on Licensing Certain Types of Activities", 8. August 2001, N 128-FL (last update 4.May 2011, N 99), pursuant to its Article 17 licenses shall be subject to the following activities:

- Collection, use, disposal, transportation and waste disposal of hazardous waste/ risk classification I - IV (there is no need of a license for the temporarily storage of waste of hazardous waste/ risk classification I - V class of hazard as well as for collection, use, disposal, transportation, waste disposal of hazardous waste/ risk classification V)

- Harvesting, processing and sale of non-ferrous metals

- Harvesting, processing and selling of scrap metal.

The “Federal Law on the protection of atmospheric air”, from 22.April 1999, N 96-FL specifies the requirements for preventing adverse effects on air during storage, dumping and disposal of industrial and municipal wastes (Article 18). It directly concerns the objects associated with the

processing and disposal of solid waste, such as waste incinerators and landfills as they are major sources of emissions.

In addition to the federal laws aforementioned, Russia also signed several international conventions and protocols regarding environmental protection and waste management and transferred them in national legislation. There are three key agreements regarding waste management:

Kyoto Protocol to the UN Convention on Climate Change, ratified in 2004 (Thus, the Protocol came into effect.)[159]. It is included in the "Resolution of the Russian Federation "Realisation of the Article 6 of the Kyoto Protocol to the UN Convention on Climate Change", from 28. October 2009 N 843. One issue within the Kyoto Protocol is the restriction and/or reduction of methane emissions through waste management.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, ratified in 1995 [160] which is emphasised in the "Resolution of the Russian Federation about the transboundary movements of waste", from 17. July 2003 N 442 (last update 15.02.2011 N 78). The Basel Convention aims to protect human health and the environment caused by generation, management, transboundary movements and disposal of hazardous and other wastes.

Stockholm Convention on Persistent Organic Pollutants, signed in Mai 2002, no ratification yet[161]. Hence, there is no law at the moment.

The Russian legislation does not state a waste management hierarchy, but considering the ratification of international instruments, waste management systems are built based on the principles of sustainable development and use that are part of the EU waste hierarchy[162].

In addition, the federal laws are supported by codes, technical regulations (GOST (state standards), OSTy (industrial standard), TU (technical specifications)), Sanitary norms and rules (SanPiN) and further documents at different status and developed at different levels (federation, region, local) such as recommendations and instructions.

Although theses standards and norms do not correspond with a law, the execution of their requirements is mandatory. Violation is punishable by fines[163].

6.2.1 Codes of the Russian Federation influencing waste management

Codes correspond (beside the Constitution) as the highest level for implementing governmental duties in Russia. Several codes have an essential impact on the development of (urban) waste management concepts. Therefore, the environmental requirements in waste management are formulated in the following codes of the Russian Federation:

The Code for Land/Soil of the Russian Federation, from 25.October 2001 N 136-FL (last update 05. April 2011 N 56-FL), Article 13 establishes the duty of the Russian State to protect the land/ soil from littering and pollution through industrial and municipal waste.

[159] UNEP, 2011
[160] SBC, 2011
[161] Stockholm Convention Secretariat, 2011
[162] Slyusar, 2011, interview
[163] Slyusar, 2011, interview

The Housing Code of the Russian Federation, from 29.December 2004 N 188-FL (last update 30. November 2010 N 328-FL), requires to ensure that common property in a tenement house is in a proper sanitary and technical condition and defines the rules for payment for housing. According to paragraph 4 of article 154 of the *Housing Code of the Russian Federation* the removal of waste is not the responsibility of public services; i.e. it is a task of management companies and homeowners' associations. The fee is a part of payment of the maintenance of the dwelling/ rent of an apartment.

The removal of solid waste is not described in the “Russian Federation Government Resolution on the procedure for providing public services to citizens”, from 23.May 2006, No. 307

Nevertheless, the “Government Resolution about choosing one management service for apartment block houses” from 6.February 2006, No 75, that management companies and homeowners' associations have to open tenders for selecting the waste collection and transportation companies for their apartment buildings. The objective of the competition is the removal of solid waste which refers to the list of required works and services for maintenance and repairs for common property owners of the premises in an apartment house.

The Russian Federation Urban Planning Code, from 29.December 2004, No 190-FL (last update (last update 27. July 2010 N 226-FL), Article 2, establishes that implementing urban development activities in compliance with the requirements of environmental protection and ecological safety is one of the main principles of the legislation. Article 35 defines different types of areas such as the area for waste disposal. Furthermore, it is stated that waste disposal site has to be settled and can not be included in areas with other purposes such as residential areas.

The *Code of Administrative offences,* from 30.December 2011, No 195-FL (last update 06.April 2011 N 68-FL), defines the responsibilities for administrative Offences /violation/infringement in the management of municipal solid waste.

Article 7.22 defines the consequences for breaking the rules for maintaining and repairing residential buildings and/ or sites.

In chapter 8, the consequences for environmental protection and natural resources offences are described: There is an established liability for failure to comply with environmental and sanitary regulations for waste management (st.8.2), as well as liability for polluting forests by industrial and domestic waste (st.8.31). Article 8.8 establishes liability for the use of land without the intended purpose, such as non-use of land intended for farming or housing or other construction, failure of mandatory measures to improve land and soil conservation. For example landfills which are operated in violation of state law and located on agricultural lands; i.e. illegal dumping is forbidden, especially on agricultural land and there is also a liability for not implementing of re-cultivation of landfill sites or protecting the soil on a landfill site. Article 8.31 also defines the consequences for breaking the rules for sanitary safety in forests (forest pollution from sewage, chemical, radioactive and other harmful substances, industrial and municipal waste). Article 8.21. defines the penalties for breaching air quality standards (this applies, for example, to gas emissions at a landfill). Article 9.4 establishes a liability for disregard to the requirement of providing project documents and legal instruments for the (construction) industry.

The Criminal Code of the Russian Federation, from 13. June 1996, N 63-FZ (last update 04. May 2011 N 97-FZ), in Article 247 stipulates responsibility for the production of prohibited hazardous waste as well as responsibility for complying with the rules regarding transportation, storage, disposal, use, or otherwise handling radioactive, bacteriological and chemical waste.

The Water Code of the Russian Federation, from 3. June 2006 N 74-FL (last update 28.12.2010 N 420-FL), and the *Forestry Code of the Russian Federation,* from 4. December 2006, N 200-FL (last update 29. December 2010 N 442-FL), describe requirements for waste disposal.

6.2.2 Key laws and objectives of waste legislation in Khanty-Mansiysk Autonomous Okrug - Ugra

The Okrug's (waste) legislation is mainly based on the federal legislation of Russia and has to be taken into consideration for developing an (urban) waste management concept such as for the town Khanty-Mansiysk. Nevertheless, there are some laws which deal especially with waste management in KMAO-Ugra.

The key law regarding waste management is also the "Federal Law on industrial and municipal waste" from 24.June 1998 No. 89 (last update 30.December 2008, N 309-FL).

In addition to the legislation of the Russian Federation, general regulation of industrial and municipal waste exists in KMAO-Ugra such as the "Law of KMAO-Ugra on regulation of certain issues in the field of environmental protection in the Khanty-Mansiysk Autonomous Okrug - Ugra" from 18.04.2007, No. 31-OL–Khanty-Mansiysk. The Act established the authority of the Government of the KMAO-Ugra to participate in the development and implementation of federal programs in the field of waste management, to participate in the provision of information in the field of waste management activities to protect the population of KMAO-Ugra.

Waste management is monitored by federal bodies and Khanty-Mansiysk Autonomous Okrug services for monitoring the environment, fauna protection and forest relations[164].

6.3 Definition of waste and waste holder, waste classification as well as waste cadastre

Municipal and industrial as well as medical waste has to be handled as a part of administrative duty and therefore, these waste streams have to be taken into account while developing urban waste management concepts such as the waste management concept for the town Khanty-Mansiysk according to "Federal Law on industrial and municipal waste" from 24.June 1998 № 89 (last update 30. December 2008, N 309-FL and "Federal Law on general principles of organisation of local self-government in Russian Federation", No.131-FL. The definition, waste holder, classification and cadastre of municipal, industrial waste and medical waste will be described.

The "Federal Law on industrial and municipal waste" from 24.June 1998 No. 89 (last update 30. December 2008, N 309-FL) defines municipal and industrial waste as stocks of raw materials, intermediate products, other goods or products which are formed during production or consumption, as well as goods (products) that have lost their consumer properties.

In the state standard GOST 30772-2001 "Resource Waste management. Terms and definitions" from 1.July 2002 waste is defined as "the remnants of an additional product or products formed during or upon completion of certain activities and not used in direct connection with these activities". The Standard also contains a number of other terms and definitions: "industrial and municipal waste", "household waste", "food waste", "biological waste", "waste of health care institutions," "hazardous waste" and others.

[164] Kornienko, 2011a

According to the “Federal Law on industrial and municipal waste" from 24.June 1998, No. 89 (last update 30. December 2008, N 309-FL) ownership of the waste belongs to the owner of raw materials, intermediate goods, products or other products and goods (products), as a result of which the waste is formed. This means that the tenants are the owners/ waste holder of the waste they produce.

In this case, the *Civil Code of the Russian Federation*, 30 November 1994, N 51-FL (last update 18.07.2009 N 181-FL) stipulates that "a citizen or legal person may waive the right to ownership of the property belonging to it, declaring this or committing other acts, that definitely show its removal from the possession, use and dispose of the property with the intention to keep any rights to this property.” By disposing the property a person waives the right to its ownership.

In addition, the *Civil Code of the Russian Federation*, 30 November 1994, N 51-FL (last update 18.07.2009 N 181-FL) says that "Movable things thrown out by the owner or otherwise left to abandon their property right (abandoned stuff), can be taken by others in their property…” It also states that a person in ownership, possession or use of land, water body or other object, which are abandoned industrial wastes and other wastes (including municipal solid waste of the population), is entitled to take these things on their property, start using or treat them. “Another object is, that for abandoned industrial wastes and other wastes should container sites for waste collection should be set. Consequently, the owner of this site (usually the municipalities/ local administration) has the right to take the waste into their property.

The “Federal Law on industrial and municipal waste", from 24.June 1998 No. 89 (last update 30. December 2008, N 309-FL), subdivides waste into municipal waste and industrial waste. Furthermore, municipal and industrial waste has to be classified according to their negative impact on the environment. The Federal Law No 89-FL subdivides industrial and municipal waste into five hazardous waste/ risk classes depending on the degree of negative impact on the environment:

- class - extremely hazardous waste
- class – high hazardous waste
- class - moderately hazardous waste
- class - low-hazard waste
- class - almost non-hazardous waste.

The hazardous waste/ risk classification is established on the basis of "criteria for identification of hazardous waste regarding the risk classes for the environment" (approved by Resolution of the Ministry of Natural Resources 15.June 2001, No. 511).

Another approach to the classification of waste is proposed by the sanitary regulations SanPin 2.1.7.1386-03 "Sanitary rules on the definition of the risks of toxic substances caused by industrial and municipal waste" 16. June 2003, N 144, which set the hygienic requirements and criteria for the definition of hazardous wastes in production and consumption according to their degree of toxicity. These rules do not apply to radioactive, explosive and flammable wastes, and waste that can cause infectious diseases (food waste, medical institutions, and deposits of household waste water).

In accordance with SanPin 2.1.7.1386-03 waste is divided into four classes regarding their impact on human beings and the environment:

- class - extremely hazardous waste
- class – high hazardous waste
- class - moderately hazardous waste
- class - low-hazard waste.

Furthermore, in accordance with the requirements of the sanitary-epidemiological rules and norms of SanPiN 2.1.7.1322-03 "Hygienic requirements for allocation and disposal of industrial and municipal waste", 30 April 2003, N 80 a separate collection of industrial waste divided by types, classes and other attributes is to be implemented in order to ensure its use as secondary raw material, processing.

Beside the management of municipal and industrial waste, the Russian legislation also describes the management of medical waste in a sanitary rule. Medical waste is classified in SanPiN 2.1.7.728-99 "Rules of the collection, storage and disposal of health care institutions", 22.January 1999, No. 2. All medical wastes are collected and disposed of separately according to their epidemiological, toxicological, and radiological hazards in five risk classes (see table 24):

table 24: Overview of hazardous classification regarding medical waste

Hazard classification	Summary of waste classification
Class A. Non-hazardous waste from ambulances, clinics and hospitals (such as food – waste similar to household waste)	Waste that was not in contact with body fluids of patients with infectious diseases, non-toxic waste. Food scraps of all health facilities except for infectious units (including the waste from dermatovenerological agencies). Furniture, equipment, faulty diagnostic equipment that does not contain toxic elements. Uninfected paper, construction debris, etc.
Class B. Hazardous waste from ambulances, clinics and hospitals	Potentially infectious waste. Tools and materials contaminated with body fluids including blood. Pathological-anatomical waste, organic operating waste (organs, tissues, etc.). All waste from infectious units (including food). Waste from microbiological laboratories working with micro-organisms 3-4 groups of pathogenicity) and biological waste bioterios.
Class V. Extremely hazardous waste from ambulances, clinics and hospitals and infectious diseases hospital	Materials in contact with patients, especially those with dangerous infections. Waste from laboratories working with micro-organisms 1-4 of pathogenicity groups. Waste from mycological hospitals and patients with anaerobic infection.
Class G. Waste from ambulances, clinics and hospitals (such as equipment, injection etc. waste similar to industrial waste)	Expired drugs, waste of medicines and diagnostic products, disinfectants, not to be used, expired. Cytostatics and other himpreparaty. Mercury-containing items, appliances and equipment.
Class D. Radioactive wastes from clinics and hospitals	All kinds of wastes containing radioactive components.

The “Federal Law on industrial and municipal waste" from 24.June 1998 No. 89 (last update 30. December 2008, N 309-FL), Article 20, also includes a waste cadastre. The cadastre is described in detail in "The determination of the federal cadastre of waste", from 2.December 2002 N 786 (last

update 30. July 2003), which contains 114 waste types with reference to one of the five hazardous waste classes. Each waste type has a code such as “100 000 00 00 00 0 - Organic waste of natural origin (from animals and plants)” which is subdivided into four passports of codification:

1. The first eight digits codify the waste origin.

2. The ninth and tenth digit encode the physical state and physical form such as solid or liquid.

3. The eleventh and twelfth digit are used to describe the hazardous properties and their combinations such as toxicity, explosive, flammability, high reactivity etc.

4. The thirteenth digit describes the class of hazardous waste/ risk classification.

The governments of Russian administrative regions, such as the government of the Khanty-Mansiysk Autonomous Okrug – Ugra, have the option to develop and manage a regional waste cadastre based on the federal cadastre.

Therefore, a regional cadastre was developed by the Government of KMAO-Ugra. The regional cadastre of KMAO-Ugra includes also the 114 federal groups, including a variation of subgroups, which are obligatory for each regional cadastre.

Nevertheless, the cadastre of 114 federal groups was extended by several sub-groups. One example is the federal group “316 000 00 00 00 0 - mineral sludge” that has eight subgroups such as “sludge of calcium carbonate”. This federal group “mineral sludge” with its eight subgroups was extended to twelve subgroups such as the subgroup “sludge from cleaning the gas which is by product of oil extraction”. Another example is the federal group “971 000 00 00 00 0 – medical waste”. In the federal cadastre there is no subgroup, the regional cadastre of KMAO-Ugra contains eight subgroups such as “injections after disinfection”. And a last example is the federal group “990 000 00 00 00 0 – other communal waste” which is not further subdivided. The regional cadastre has three subgroups; all for snow from different places such as from cleaning roads, local areas and industrial sites.

It can be summarised that the regional cadastre was adapted to the local conditions such as special waste from the oil and gas industry and the northern location of KMAO-Ugra within Siberia were snow as waste also plays a special role.

As the number of each federal and subgroup includes the hazardous waste classification from I-V (the last figure of the number), the cadastre has to be considered for the development of an urban waste management concept for controlling which type of waste can be disposed of on the landfill.

6.4 Development of waste management concepts

According to SanPiN 42-128-4690-88 "Sanitary Regulations for the content of populated areas”, 05.August 1988 the development of a waste management concept is essential; i.e. a general scheme of cleaning settlements has to be prepared. The general scheme needs to be developed for groups of settlements, regions, agglomerations, provinces and districts. The administration of the city/ region has to prepare this scheme.

Additionally, the requirements for the general scheme are defined in MDK 7-01.2003 "Guidelines on how to develop general schemes for cleaning areas of human settlements of the Russian Federation" 21.August 2003, N 152. The main document of such a scheme defines the scope of work, methods of collection, removal, disposal and recycling, required number of emergency

vehicles, machinery, equipment and tools for system cleaning and cleaning of urban areas, the size of the construction as well as reconstruction or expansion of waste facilities. Therefore, the general cleaning scheme should include:

- General information about the city and climatic conditions
- Information about the existing condition of waste management and the long-term development
- Data on the current status of sanitation and cleaning
- Materials on organization and technology of collection and disposal of household waste
- Payment rates and volumes of work
- Methods of waste disposal
- Technology of mechanical cleaning of streets/ roads (in and outside towns), squares, sidewalks and isolated areas
- Calculation of the required number of special machines and mechanisms for types of work
- Organisational structure of enterprises of sanitation and cleaning
- Investment in activities to clean up areas;
- Graphic part and the main provisions of the scheme.

In the guideline on how to develop general schemes there are different methodologies which can be used for developing the general scheme. These methodologies are not approved by the federal state. Therefore, the guideline is a recommendation and not legally binding.

6.5 Legislation for the enforcement of waste facilities including landfills and disposal of sewage sludge

Currently, there are no requirements in Russia governing the construction of incinerators and/ or waste sorting plants and/or different waste treatment facilities. Therefore, the waste treatment facilities have to be built with the same requirements as other technical facilities, i.e. the construction of waste facilities has to pass state environmental and public examination. Site selection for construction of the incinerator has to be considered on zoning of areas such as settlement or natural zones (compare SanPiN 2.1.7.1322-03 "Hygienic requirements for allocation and disposal of industrial and municipal waste", 30 April 2003, N 80). Generally, incinerators are not permitted to be sited in sanitary protection zones of water, in areas of recreation and in areas of therapeutic institutions, natural protection zones etc.

For the construction of a landfill, the “Instruction on designing, operating and reclaiming landfills for municipal solid waste”, of 5. February 1997, No. EE-8, has to be taken into consideration.

It is the state’s ecological expert’s responsibility to develop the documentation for constructing waste facilities including landfills as well as for the treatment and disposal of hazardous waste classes I-IV on landfills which has to meet all the requirements of environmental legislation.

Monitoring is mandatory for landfills. Specialised monitoring for incineration and/ or waste treatment plants does not exist; they are covered by acts for buildings and factories.

The designer of the landfill is responsible for the monitoring while planning the landfill; the owner of the landfill is responsible for implementing the monitoring in agreement with the local authorities; in the case of KMAO-Ugra: Municipality of Khanty-Mansiysk “Municipal road - operational enterprise” (M DEP) as the owner of the landfill has to agree with the Department of town-planning, architecture and housing and communal services of Khanty-Mansiysk.

Monitoring is carried out in accordance with SanPiN 2.1.7.1038-01 "Hygienic requirements for design and content sites for solid waste", 30 May 1996. No 16, (last update 24.July 2000, No. 554) and components such as waste disposed on the landfill have to be monitored. It also includes the controlling of groundwater and surface water, air, soil, sediment and plant noise pollution and the zone of possible adverse effects of landfills.

SanPiN 2.1.7.1322-03 "Hygienic requirements for allocation and disposal of industrial and municipal waste", 30 April 2003, N 80 describes in detail the hygienic requirements for operating and construction of a landfill.

Furthermore, this SanPin 2.1.7.1322-03 "Hygienic requirements for allocation and disposal of industrial and municipal waste", 30 April 2003, N 80 describes on where landfill sites can be built. Landfills have to be located outside residential zones and should include a sanitary protection zone of 1.000 m. It is also forbidden to construct a landfill site in sanitary protection zones of water, in areas of recreation and in areas of therapeutic institutions etc. such as other waste treatment plants aforementioned. The SanPin also forbids the disposal of cadaver.

According to the SanPin 2.1.7.1322-03 "Hygienic requirements for allocation and disposal of industrial and municipal waste", 30 April 2003, N 80, the construction of a landfill should include:

- Identification system of waste
- Impervious screen of waste
- collection and removal of leachate
- drainage system
- top cover remediation
- temporary roads.

In landfill operation, wastes should not be accepted any how without inspection. The waste disposal trucks that bring the waste to the landfill site should be inspected such as via visual examination if the waste disposal truck is open. Secondly, the weigh of the truck with of all waste should be measured through a weighbridge. After weighing the waste, it will be driven to the special prepared places where the waste will be unloaded. In order to properly calculate the amount of waste, the waste disposal truck is weighed again after dumping the waste. Finally, after the reweighing, the truck has to undergo wheel cleaning process. This is a way of ensuring that the trucks are properly kept clean before they are driven out of the dumping ground.

The waste which is disposed of should be layered and compacted and finally, a daily insulation layer of inert waste ground should cover the waste.

For closing a landfill site, the SanPin explains two stages: a technical and a biological stage. The technical stage includes forming a plate of waste and creating a recultivation coating of clay and a layer of fertile soil, including the establishing of a degassing system. The biological stage provides for grass seeding (or tree planting) on the surface of the landfill.

There are also SanPiN 2.2.1./2.2.1.1200-03 "Sanitary protection zones and sanitary classification of enterprises, buildings and other facilities", and "How to design, operate and reclaim landfills for municipal solid waste" which includes hygiene rules for designing a landfill as well as for selecting a site for the landfill, 29.January 2003, N 4459.

The existence of chemical contamination also has to be assessed in accordance with SanPiN 4630-88 "Hygienic requirements for surface water through pollution". Hydro-chemical groundwater samples have to be taken from control wells or wells, laid above or below the landfill on groundwater flow. The testing of surface water sources above and below the landfill site is carried out based on sanitary-chemical and bacteriological helminthological indicators in accordance with SanPiN 2.1.5.980-00 "Hygienic requirements for surface waters".

In compliance with SanPiN 2.1.7.1038-01 "Hygienic requirements for design and content sites for solid waste", 30 May 1996. No 16, (last update 24.July 2000, No. 554) ambient air is sampled over the exhaust portions of landfill and on the border to the sanitary-protective zone. to

The content of toxic exogenous chemicals in accordance with SanPiN 2.1.7.1287-03, "Sanitary-epidemiological requirements to the quality of the soil"17. April 2003, N53, has to be determined.

Furthermore, there are technical standards and recommendations for disposal of waste and operation of landfills:

- Guidance on the calculation of the quantitative characteristics of pollutant emissions from municipal solid waste landfills, Moscow, 1995
- Recommendations for the calculation of biogas and the choice of degasification systems of landfill.– Moscow, State Committee for Construction and Housing, 2003
- Recommendations for the collection, treatment and disposal of waste water from landfills of municipal solid waste, Moscow, State Committee for Construction and Housing, 2003

All these documents such as sanitary rules (SanPin), guidelines (GOST), instructions and recommendations are key documents that detail the requirements for the selection of sites for landfills and the structural requirements for facilities and technology which has to be used to operate a landfill.

The monitoring system should provide constant information on the condition of soil, sediments and plants in the zone of potential impact of landfills.

According to the requirements of "Federal Law on industrial and municipal waste" from 24. June 1998 No. 89 (last update 30.December 2008, N 309-FL) legal persons and organisations performing activities on waste management, are required to conduct environmental monitoring of waste disposal sites. The aim is to record and assess the landfill's impact on air, surface and underground water as well as soil.

Regarding the disposal of sewage sludge, there are mainly sanitary regulations and technical standards set by Russian legislation which describe the handling of sewage sludge. In these rules

and standards the limit values for sludge components, especially for heavy metal such as lead, cadmium, chromium, copper, nickel, quicksilver, zinc are determined as well as the maximal sludge dosage for introduction into a soil. The key documents are:

SanPiN 2.1.7.573-96 “Hygienic requirements to wastewater and sewage sludge use for land irrigation and fertilization”, 31.October 1996, N 46

GOST R 17.4.3.07-2001 “Requirements to wastewater sludge for its application as a fertiliser”, 1.October 2011.

6.6 Fee and penal system for industrial and municipal waste disposal

Usually, the process of waste disposal in Russia, including KMAO-Ugra, is as follows (see figure 21):

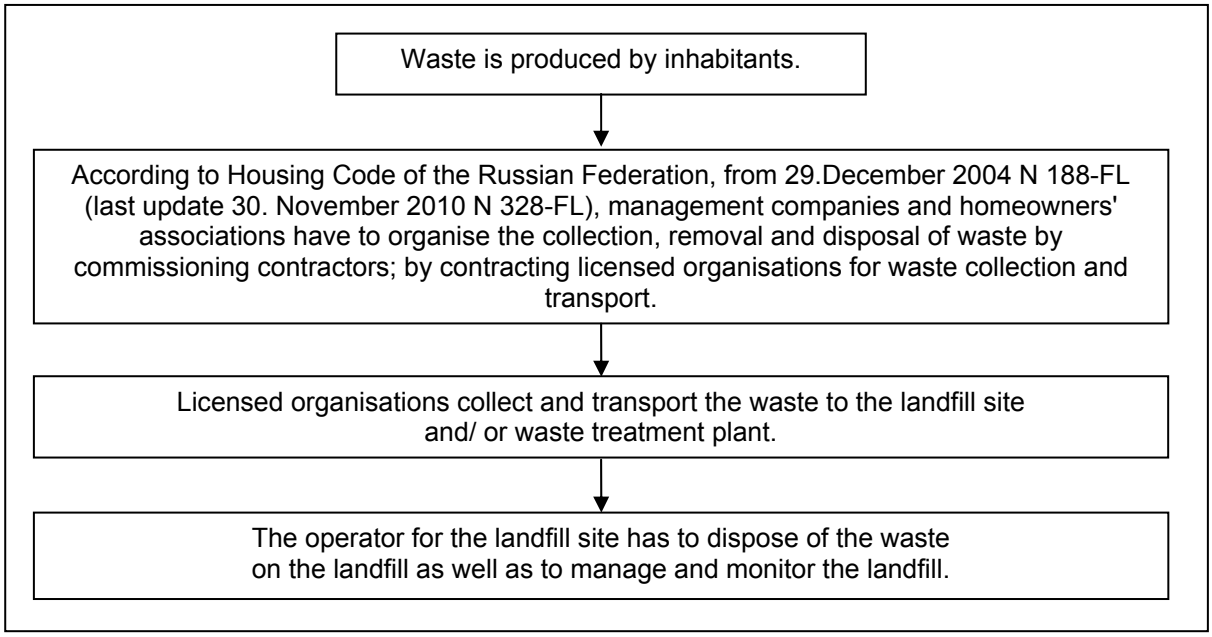


figure 21: Responsibilities along the process of waste disposal in Russia

The collection and transportation of MSW (municipal solid waste) is not a responsibility of the public services (compare also *Housing Code of the Russian Federation* from 29.December 2004 N 188-FL (last update 30.November 2010, No. 328-FL). A charge for the collection and transportation of waste is included in the fee for maintaining common property in an apartment house. This fee depends on the tariff for collection, transportation and disposal of solid waste established by an organisation that collects waste. These carrier organisations have to have a license which they can get from Federal Service for supervision of nature management in their region or town such as Territorial Management of Federal Service for supervision in the sphere of nature management in KMAO-Ugra.

Fees for the collection and disposal of waste from apartment buildings are set to manage their organisation. Homeowners which deal with the maintenance of housing have to set this fee. In private homes residents sign an agreement on the collection and disposal of waste, often directly with the refuse collection operator. Consequently, if such a contract does not exist, no payment for refuse collection and disposal is done.

One of the principle applicable environmental legislation of the Russian Federation is the payment for environmental management. This is a form of compensation for environmental pollution caused by primary use of natural resources for economic benefits. The “Federal Law on industrial and municipal waste" from 24.June 1998 No. 89 (last update 30. December 2008, N 309-FL) allows charges for the disposal of waste from individual entrepreneurs and legal entities. The amount of payment is determined in accordance with the Government of the Russian Federation from 12.June 2003 No. 344 "Resolution on rates of charges for air emissions of pollutants from stationary and mobile sources, discharges of pollutants into surface and ground water bodies, industrial and municipal waste”. A violation of the legislation on waste management can be followed by different types of actions:

- Disciplinary
- Administrative
- Criminal
- Civil Law.

The Russian Federation Code of Administrative Offences from 30.12.2001 No. 195-FL Russian Federation “Code of Administrative Offences” sets penalties for administrative offences in environmental protection. The Code also *imposes* criminal *liability for breaching* environmental and sanitary requirements during collection, storage, use, neutralization, transportation, accommodation and other treatment of industrial and municipal waste or other hazardous substances. Citizen fines and/ or administrative fines have to be paid for any kind of activities which are carried out without a legal entity.

Although there is a law which provides for payment for the disposal of industrial and municipal waste, there is a deficit of mechanisms for signing contracts for payment of waste fees. If there is no contract between inhabitants or owners of apartment blocks/ companies/shops etc. and the waste disposal company or local administration, inhabitants or owners of apartment blocks/companies/shops etc. do not pay for their waste disposal. Consequently, the waste disposal companies need the financial support of the local authorities[165]. Usually the payment for waste management is covered by general tax revenues and/ or local/municipal revenues as well as state subsidies for local budgets. Local/ municipal revenues include rent of apartment or payment obligations from home and building owners. Both (rent and payment obligations) only include a very low waste charge.

That is also an issue in the town Khanty-Mansiysk. Currently, the waste disposal of municipal waste is mainly paid by the local authorities.

6.7 Regulatory bodies for waste management

In Russia, two federal ministries and three federal services (see figure 22) exist to regulate environmental affairs and they are specially authorized to control the implementation of waste management.

[165] Tomsha, 2007

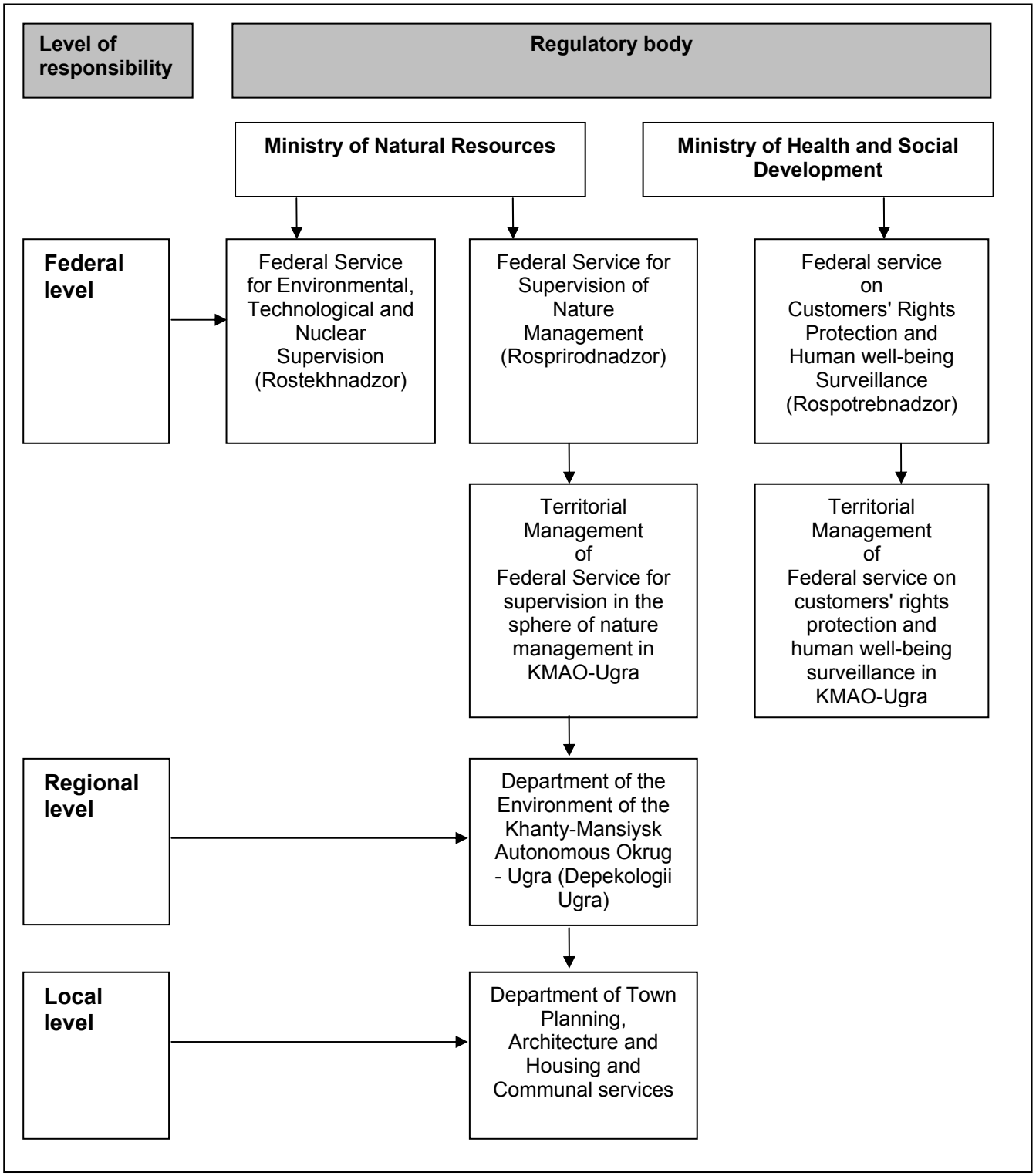


figure 22: Regulatory bodies responsible for waste management on the example KMAO-Ugra and Khanty-Mansiysk

Waste management and disposal is a responsibility of Rosprirodnadzor and Rospotrebnadzor. They correspond to executive bodies for state regulations of waste management; i.e. they accomplish the organisation and realisation of ecological control, they develop laws and norms and co-ordinate with other federal institutions in this area in Russia.

The Federal service on customers' rights protection and human well-being surveillance (Rospotrebnadzor) is in charge of controlling the hygienic conditions in urban areas and settlements. From this service different laws developed such as Federal Law on the sanitary-epidemiological welfare of the population, from 30.March 1999, No 52-FL (last update 28.September 2010, No.243-FL) and sanitary rules such as SanPiN 42-128-4690-88 "Sanitary Regulations for the content of populated areas", from 05.August 1988.

The Federal Service for supervision of nature management (Rosprirodnadzor) has to control the implementation of ecological protection during the process of waste treatment and waste disposal.

Both Rospotrebnadzor and Rosprirodnadzor are further subdivided into Territorial Managements such as Territorial Management of Federal Service for supervision of nature management in KMAO-Ugra and Territorial Management Federal service on customers' rights protection and human well-being surveillance in KMAO-Ugra. These Territorial Management Services are mainly responsible for implementing laws, acts etc. in the region/ territory of their duty.

The Federal Service for Environmental, Technological and Nuclear Supervision (Rostekhnadzor) had the task of waste management and disposal until 2009; currently it has the responsibility for controlling of waste from nuclear power stations.

For implementing waste management concepts in KMAO-Ugra, there are three regulatory bodies on different state levels responsible with different duties (see figure 22).

The ***Federal Service for Supervision of Natural Resources (Rosprirodnadzor) in the Khanty - Mansiysk Autonomous Okrug – Ugra*** controls and supervises compliance with the environmental protection legislation of the Russian Federation, including air protection and waste policies (except radioactive waste). It also organises and conducts the state environmental review at the federal level in accordance with the legislation of the Russian Federation. The Federal Service is responsible to permit the transboundary movement of wastes, ozone depleting substances and products as well as the establishment of waste disposal facilities within its jurisdiction. Furthermore, it co-ordinates the work on maintaining the state cadastre of waste and public records in waste management as well as check out the validity of established classification of hazardous wastes to the environment. Finally, it allocates licenses to legal entities and individual entrepreneurs engaged in the same kind of economic or other activities to collect, use, disposal, transportation and waste disposal of I-IV risk classes. Parallel, Rosprirodnadzor in the Khanty - Mansiysk Autonomous Okrug – Ugra represents the interface between the federal level and administrative regions of the Federation of Russia.

The ***Department of the Environment of the Khanty-Mansiysk Autonomous Okrug - Ugra (Depekologii Ugra)*** performs the functions of implementing the unified state policy, legal regulation and the provision of public services in the field of industrial and municipal waste. In addition, it participates in federal and regional programs in the field of waste management and provides public information about environmental conditions in the autonomous region, including in waste management. The department also maintains a regional cadastre which includes the regional waste catalogue, and a list of places where landfills are and a data bank about which technology is used in the region.

The ***Department of town planning, architecture and housing and communal services*** is responsible for the management of waste generated in the town Khanty-Mansiysk. In accordance with Paragraph 25, Article 16 of "Federal Law on general principles of organisation of local self-government in Russian Federation", No.131-FL collection, transportation, disposal and recycling of

household and industrial waste are a duty of local administration. Different departments are responsible for this duty such as the Department of town planning, architecture and housing and communal services of the town Khanty-Mansiysk.

Currently, the duty only includes the collection, transportation, and disposal of household and industrial waste; there is no waste recycling program in use in the town Khanty-Mansiysk.

6.8 Future development of waste legislation in Russia and of waste management in Khanty-Mansiysk Autonomous Okrug - Ugra

In the near future, two changes can be expected in waste legislation on federal level.

Firstly, the “Federal Law on Licensing Certain Types of Activities", coming into force in 2001, will be changed in the next three month. The rule that only licensed companies can transport waste will be omitted which means that all existing companies and/ or communal services can transport waste without any license[166].

Secondly, in 2006, a draft version of the federal “Law on packaging and packaging waste” was proposed which is intended to set the legal basis for the treatment of packaging and packaging waste in order to ensure environmental safety and human health, prevent negative impacts on the environment, as well as including packaging waste in the economic turnover as an additional source of raw materials. The draft law was rejected by the State Duma of the Russian Federation with the recommendation to develop an appropriate technical regulation. Currently, in Russia there is no legislative framework that establishes requirements for the separate collection of industrial or municipal waste.

In KMAO-Ugra, in 2007, a “Concept of Ecological Safety Khanty-Mansiysk Autonomous Okrug – Ugra for the time period until 2020”, from 10.April 2007, No. 110-RR, was developed which includes the management of industrial and municipal waste. The main purpose of its development was to ensure improvements in the treatment of industrial and municipal waste and to reduce the negative impact of waste on the environment and health in KMAO-Ugra. It also includes to maximise their involvement in economic circulation and to attract investments to the industry of waste management in KMAO-Ugra.

In order to achieve these goals, it requires comprehensive and systematic sub-objectives:

- Improving the legal framework for waste management
- Implementing an effective waste management scheme in the autonomous region with the best available technology
- Construction of new landfills for municipal solid and industrial wastes as well as reconstruction and modernisation of existing landfills of municipal solid and industrial wastes, taking into account the current low supply of authorized landfills
- Elimination of existing and prevention of future illegal landfills in KMAO-Ugra, including littering of land/ soil
- Improvement of mechanisms of interaction between state authorities, local government municipalities and businesses in the area of waste management and
- Increase of ecological culture and education about sustainable waste management.

[166] Slyusar, 2011, interview

7. Conclusion

The major aim of the key law regarding waste management in Russia "Federal Law on industrial and municipal waste" from 24.June 1998 No. 89 (last update 30.December 2008, No. 309-FL) is to prevent negative impacts on the health of human beings and the environment caused by wrong waste disposal. Furthermore, the recycling of materials from waste as a source for commodities and economic revenues is to implement by local authorities.

The local authorities are responsible for achieving those aims and organising the transport, the disposal and the recycling of waste according to the law aforementioned. Therefore, a sustainable waste management concept has to be developed.

The current waste management in Khanty-Mansiysk consists of collecting the waste daily and disposing of it on the landfill. Based on the extreme increase of waste amount and change of waste composition caused by a rapidly growing economy and migration boom in the town Khanty-Mansiysk, the infrastructure for waste management in Khanty-Mansiysk is no longer sufficient to accommodate the demands of the current waste disposal.

The management of waste collection and disposal is one of the main problems of the local administration in Khanty-Mansiysk. For that reason, the key objectives of the project are to develop a sustainable waste management concept for the town Khanty-Mansiysk, to strengthen the waste management, and to explore through a market analysis the possibility of gaining profit from recycling and selling of waste.

However, the research for the status-quo report demonstrates there are challenges which the future waste management concept has to deal with:

According to the waste prognosis, a doubled waste amount by 2014 has to be taken into account while developing the urban waste management concept. This increase is a result of an expected further increase of population in the town Khanty-Mansiysk and increase of economic growth. In addition, the existing sewage treatment plant will be expanded; a rise of sewage sludge for disposal can be expected as well. These facts play an important role for selecting the types and capacities of waste collection, transport and treatment facilities.

Furthermore, Khanty-Mansiysk is located in KMAO-Ugra/ Western Siberia where and bogs and swamps dominate the landscape. 60% of KMAO-Ugra is covered by bogs, swamps, fens and meadows on river floodplains. Khanty-Mansiysk is surrounded by two big rivers and their floodplains as well as huge areas of bogs and swamps; i.e. a construction of a landfill site and/ or a waste treatment plant is hardly possible. That means the area for possible waste disposal sites and/ or sites for treatment plants is extremely limited by natural conditions.

Khanty-Mansiysk is well integrated into the federal roads and navigable water systems. Nonetheless, Khanty-Mansiysk is not connected with the railway system and it is relatively isolated compared to other towns in KMAO-Ugra such as Surgut and Neftyuganz. The distance from Khanty-Mansiysk to other towns is more than 200 km. This means that ways for waste transport are long and/ or transfer stations have to be planned in appropriate places.

Additionally, the climate is severe; i.e. winter periods very long and cold and summer periods short and hot. Consequently, the collection, transport and treatment technology has to resist low temperatures and meet robust requirements on their material.

At the moment, there is no complete data bank for waste amount and waste composition generated in Khanty-Mansiysk. There is a weighbridge at the entrance of the landfill since November 2006 but the waste amount is still recorded in m^3. Experiences prove that this can lead to un-reliable data, especially while planning the capacity of waste treatment plants. The waste composition is not recorded at the entrance of the landfill yet. Therefore, the continuous development of a data bank is essential as only reliable data can lead to the preparation of a sustainable waste management concept.

With 39.2% of average water content, the municipal waste shows approximately only 6.800 KJ/kg ($Hu_{(roh)}$) per waste of heating value, i.e. the waste is hardly useable for waste incineration in order to produce heat or energy for a sufficient use in the town Khanty-Mansiysk.

The research about the waste legislation demonstrates clearly that there is a strong policy to support integrated waste management. However, its implementation is weak and the waste management structure in Khanty-Mansiysk is still underdeveloped such as the implementation of a recycling structure. The result is that approximately 99% of the entire waste generated in Khanty-Mansiysk is disposed of on the landfill without any treatment.

At the moment, the local administration is responsible for the disposal of the waste produced in Khanty-Mansiysk. Collection and transport is also paid by the inhabitants and private companies. Usually, a new waste management concept is connected with an increase of costs.

For developing an urban waste management concept in Khanty-Mansiysk, technical requirements given by the Russian law have to be considered as well. SanPiN 42-128-4690-88 "Sanitary regulations for settlements", from 05.August 1988 does not allow more than five waste containers at each waste disposal site. Furthermore, the waste container site is not allowed to be closer than 20m or not further away than 100m from a house. This factor and the fact that some current waste disposal sites are fenced need to be considered for a recycling strategy and it has to be checked whether the technical requirements can be achieved.

The research for the status quo report also proves that the present volume of waste containers is too little and need to be increased.

Last but not least, some streets in Khanty-Mansiysk can not be entered by waste disposal trucks with a payload of 9 Mg. The availability of special waste disposal cars is necessary.

Beside the challenges, there are also chances for the future waste management concept:

Khanty-Mansiysk shows stable economic conditions with a growing economy; i.e. the local administration expects that there will be an increase of the average gross income per capita for the next years. The average income in KMAO-Ugra is higher than the average Russian income.

70% of the municipal waste consists of four main fractions (organic, cardboard/paper, plastic and glass) which are very suitable for recycling. That also includes a high potential of reducing the volume of waste which is to be delivered to the landfill through recycling.

The results of the market analysis demonstrate that currently there is hardly a market for recycling products in KMAO-Ugra. Furthermore, there is no treatment plant for recycling in the town Khanty-Mansiysk. Nevertheless, there are three companies in Khanty-Mansiysk which deal with materials from the waste: paper/cardboard, metal and end-of life tyres. Beside these companies, the regional administration is interested to strengthen the recycling market in KMAO-Ugra.

In conclusion, it can be stated that the local administration which is responsible for the waste management in the town Khanty-Mansiysk has the ability to collect and transport the entire generated waste daily out of the town. They also have space for a landfill available in order to dispose of the municipal waste every day. Nevertheless, this space is limited by natural conditions and based on the forecasted migration boom and economic growth an extreme increase of waste amount can be assumed. Furthermore, there is hardly a control of delivering of hazardous waste to the landfill.

As a result, the volume of waste which is disposed of on the landfill has to be reduced and hazardous waste has to be avoided on the landfill. The insufficient situation of waste management at the moment does not fulfil the requirements of the key law for waste management aforementioned. A key for the future will be therefore to ensure a protection of human beings and environment by implementing a sustainable waste management concept.

Appendix 1 - List of waste catalogue

table 1-1: Sorting catalogue of waste analysis implemented in Khanty-Mansiysk in February and June 2011

1st category		No	2nd category
1.	Organic	1-1	Biodegradable Kitchen/Canteen Waste
		1-2	Biodegradable Garden/Park Waste
		1-3	Other Biodegradable Waste
2.	Wood	2-1	Wood untreated
		2-2	Wood treated
3.	Paper and Cardboard	3-1	Non-biodegradable paper
		3-2	Paper/cardboard – packaging
		3-3	Paper/cardboard– non packaging
		3-4	Newspapers
4.	Plastics	4-1	Plastic Film – packaging
		4-2	Plastic Film – non packaging
		4-3	Dense Plastic – packaging
		4-4	Dense Plastic – non packaging
5.	Glass	5-1	Clear Glass Packaging
		5-2	Brown Glass Packaging
		5-3	Other Glass Packaging
		5-4	Miscellaneous Non Packaging Glass
6.	Textiles	6-1	Clothes
		6-2	Non-clothing textiles
7.	Metals	7-1	Ferrous Packaging
		7-2	Miscellaneous Ferrous
		7-3	Aluminium Packaging
		7-4	Miscellaneous Non-ferrous
8.	Hazardous Household Waste	8-1	Batteries/Accumulators
		8-2	Miscellaneous hazardous waste
9.	Composites	9-1	Composite Packaging
		9-2	Composite Non-packaging
		9-3	WEEE
10.	Other Categories	10-1	Soil and Stones
		10-2	Other inert
		10-3	Nappies
		10-4	Health Care/Biological Wastes
		10-5	Miscellaneous Categories
11.	Fine fraction	11	10mm sieved fraction

Appendix 2 - Detailed results of waste analysis

table 2-1: Results of sampling within the waste analysis in winter [kg w^{-1}]

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	215	338	289	93	935
	1-2	Biodegradable Garden/Park Waste	15	5	3	2	24
	1-3	Other Biodegradable Waste	17	15	17	14	63
Wood	2-1	Wood untreated	0	10	8	1	19
	2-2	Wood treated	0	6	13	0	19
Paper/ Cardboard	3-1	Non-biodegradable paper	1	4	10	3	18
	3-2	Paper/cardboard – packaging	8	46	50	23	126
	3-3	Paper/cardboard– non packaging	6	49	72	45	172
	3-4	Newspapers	5	10	5	0	20
Plastics	4-1	Plastic Film – packaging	25	41	42	13	121
	4-2	Plastic Film – non packaging	3	13	4	4	24
	4-3	Dense Plastic – packaging	25	63	54	13	154
	4-4	Dense Plastic – non packaging	3	9	7	1	19
Glass	5-1	Clear Glass Packaging	65	96	100	11	271
	5-2	Brown Glass Packaging	9	9	29	0	47
	5-3	Other Glass Packaging	23	44	39	4	109
	5-4	Miscellaneous Non Packaging Glass	2	6	2	0	10
Textiles	6-1	Clothes	4	9	6	1	20
	6-2	Non-clothing textiles	1	5	2	0	9
Metals	7-1	Ferrous Packaging	7	19	9	2	38
	7-2	Miscellaneous Ferrous	13	7	8	3	30
	7-3	Aluminium Packaging	3	9	5	1	17
	7-4	Miscellaneous Non-ferrous	0	2	1	0	3
Hazardous Waste	8-1	Batteries/Accumulators	0	0	1	0	1
	8-2	Miscellaneous hazardous waste	0	12	15	0	27
Composites	9-1	Composite Packaging	12	39	22	6	79
	9-2	Composite Non-packaging	0	0	0	0	0
	9-3	WEEE	1	5	3	1	10
Other Categories	10-1	Soil and Stones	0	0	22	0	22
	10-2	Other inert	26	101	50	0	177
	10-3	Nappies	14	30	25	1	69
	10-4	Health Care/Biological Wastes	2	3	6	1	11
	10-5	Miscellaneous Categories	5	30	8	1	44
Fine fraction	11-1	10mm sieved fraction	35	79	49	14	177
Total			**544**	**1,113**	**974**	**258**	**2,889**

table 2-2: Results of sampling within the waste analysis in summer [kg w^{-1}]

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	128	239	128	162	658
	1-2	Biodegradable Garden/Park Waste	10	26	61	1	98
	1-3	Other Biodegradable Waste	6	9	6	5	26
Wood	2-1	Wood untreated	18	13	9	15	54
	2-2	Wood treated	2	61	1	0	64
Paper/ Cardboard	3-1	Non-biodegradable paper	1	7	8	3	19
	3-2	Paper/cardboard – packaging	22	33	41	28	124
	3-3	Paper/cardboard– non packaging	10	19	27	21	76
	3-4	Newspapers	6	2	4	6	18
Plastics	4-1	Plastic Film – packaging	21	40	31	54	145
	4-2	Plastic Film – non packaging	7	4	10	4	26
	4-3	Dense Plastic – packaging	20	41	36	15	112
	4-4	Dense Plastic – non packaging	14	15	9	12	50
Glass	5-1	Clear Glass Packaging	20	61	45	20	146
	5-2	Brown Glass Packaging	6	10	12	10	38
	5-3	Other Glass Packaging	11	28	30	7	76
	5-4	Miscellaneous Non Packaging Glass	16	8	4	0	28
Textiles	6-1	Clothes	16	15	8	5	44
	6-2	Non-clothing textiles	11	10	2	3	27
Metals	7-1	Ferrous Packaging	4	6	5	2	17
	7-2	Miscellaneous Ferrous	79	6	2	6	93
	7-3	Aluminium Packaging	4	9	4	2	18
	7-4	Miscellaneous Non-ferrous	6	2	0	0	8
Hazardous Waste	8-1	Batteries/Accumulators	0	0	0	0	1
	8-2	Miscellaneous hazardous waste	1	1	1	0	3
Composites	9-1	Composite Packaging	7	18	12	6	42
	9-2	Composite Non-packaging	6	7	2	2	16
	9-3	WEEE	2	6	34	0	42
Other Categories	10-1	Soil and Stones	0	41	0	16	57
	10-2	Other inert	22	58	42	2	125
	10-3	Nappies	13	33	10	4	60
	10-4	Health Care/Biological Wastes	0	2	1	0	4
	10-5	Miscellaneous Categories	12	28	14	2	56
Fine fraction	11-1	10mm sieved fraction	17	31	21	7	76
Total			**518**	**888**	**623**	**419**	**2,448**

table 2-3: Calculated waste amount per stratum and per waste category for winter period [Mg w^{-1}]

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	46	65	37	24	172
	1-2	Biodegradable Garden/Park Waste	3	1	0	1	5
	1-3	Other Biodegradable Waste	4	3	2	4	12
Wood	2-1	Wood untreated	0	2	1	0	3
	2-2	Wood treated	0	1	2	0	3
Paper/ Cardboard	3-1	Non-biodegradable paper	0	1	1	1	3
	3-2	Paper/cardboard – packaging	2	9	6	6	23
	3-3	Paper/cardboard– non packaging	1	9	9	12	32
	3-4	Newspapers	1	2	1	0	4
Plastics	4-1	Plastic Film – packaging	5	8	5	3	22
	4-2	Plastic Film – non packaging	1	2	1	1	5
	4-3	Dense Plastic – packaging	5	12	7	3	28
	4-4	Dense Plastic – non packaging	1	2	1	0	3
Glass	5-1	Clear Glass Packaging	14	18	13	3	48
	5-2	Brown Glass Packaging	2	2	4	0	7
	5-3	Other Glass Packaging	5	8	5	1	19
	5-4	Miscellaneous Non Packaging Glass	0	1	0	0	2
Textiles	6-1	Clothes	1	2	1	0	4
	6-2	Non-clothing textiles	0	1	0	0	2
Metals	7-1	Ferrous Packaging	2	4	1	1	7
	7-2	Miscellaneous Ferrous	3	1	1	1	6
	7-3	Aluminium Packaging	1	2	1	0	3
	7-4	Miscellaneous Non-ferrous	0	0	0	0	1
Hazardous Waste	8-1	Batteries/Accumulators	0	0	0	0	0
	8-2	Miscellaneous hazardous waste	0	2	2	0	4
Composites	9-1	Composite Packaging	3	7	3	1	14
	9-2	Composite Non-packaging	0	0	0	0	0
	9-3	WEEE	0	1	0	0	2
Other Categories	10-1	Soil and Stones	0	0	3	0	3
	10-2	Other inert	6	19	6	0	31
	10-3	Nappies	3	6	3	0	12
	10-4	Health Care/Biological Wastes	0	1	1	0	2
	10-5	Miscellaneous Categories	1	6	1	0	8
Fine fraction	11-1	10mm sieved fraction	7	15	6	4	33
Total			**116**	**213**	**124**	**67**	**520**

table 2-4: Calculated waste amount per stratum and per waste category for summer period [Mg w^{-1}]

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	27	46	16	42	132
	1-2	Biodegradable Garden/Park Waste	2	5	8	0	15
	1-3	Other Biodegradable Waste	1	2	1	1	5
Wood	2-1	Wood untreated	4	2	1	4	11
	2-2	Wood treated	1	12	0	0	12
Paper/ Cardboard	3-1	Non-biodegradable paper	0	1	1	1	3
	3-2	Paper/cardboard – packaging	5	6	5	7	24
	3-3	Paper/cardboard– non packaging	2	4	3	5	15
	3-4	Newspapers	1	0	0	2	4
Plastics	4-1	Plastic Film – packaging	4	8	4	14	30
	4-2	Plastic Film – non packaging	2	1	1	1	5
	4-3	Dense Plastic – packaging	4	8	5	4	21
	4-4	Dense Plastic – non packaging	3	3	1	3	10
Glass	5-1	Clear Glass Packaging	4	12	6	5	27
	5-2	Brown Glass Packaging	1	2	2	3	7
	5-3	Other Glass Packaging	2	5	4	2	13
	5-4	Miscellaneous Non Packaging Glass	3	2	1	0	5
Textiles	6-1	Clothes	3	3	1	1	9
	6-2	Non-clothing textiles	2	2	0	1	6
Metals	7-1	Ferrous Packaging	1	1	1	1	3
	7-2	Miscellaneous Ferrous	17	1	0	2	20
	7-3	Aluminium Packaging	1	2	0	0	3
	7-4	Miscellaneous Non-ferrous	1	0	0	0	2
Hazardous Waste	8-1	Batteries/Accumulators	0	0	0	0	0
	8-2	Miscellaneous hazardous waste	0	0	0	0	1
Composites	9-1	Composite Packaging	1	3	2	2	8
	9-2	Composite Non-packaging	1	1	0	0	3
	9-3	WEEE	1	1	4	0	6
Other Categories	10-1	Soil and Stones	0	8	0	4	12
	10-2	Other inert	5	11	5	0	22
	10-3	Nappies	3	6	1	1	11
	10-4	Health Care/Biological Wastes	0	0	0	0	1
	10-5	Miscellaneous Categories	3	5	2	1	10
Fine fraction	11-1	10mm sieved fraction	4	6	3	2	14
Total			**111**	**170**	**79**	**109**	**469**

table 2-5: Waste amount per capita and week in winter [kg c^{-1} w^{-1}]

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	2.3	1.6	2.1	1.9
	1-2	Biodegradable Garden/Park Waste	0.2	0.0	0.0	0.1
	1-3	Other Biodegradable Waste	0.2	0.1	0.1	0.1
Wood	2-1	Wood untreated	0.0	0.0	0.1	0.0
	2-2	Wood treated	0.0	0.0	0.1	0.0
Paper/ Cardboard	3-1	Non-biodegradable paper	0.0	0.0	0.1	0.0
	3-2	Paper/cardboard – packaging	0.1	0.2	0.4	0.2
	3-3	Paper/cardboard– non packaging	0.1	0.2	0.5	0.3
	3-4	Newspapers	0.1	0.0	0.0	0.0
Plastics	4-1	Plastic Film – packaging	0.3	0.2	0.3	0.2
	4-2	Plastic Film – non packaging	0.0	0.1	0.0	0.0
	4-3	Dense Plastic – packaging	0.3	0.3	0.4	0.3
	4-4	Dense Plastic – non packaging	0.0	0.0	0.0	0.0
Glass	5-1	Clear Glass Packaging	0.7	0.5	0.7	0.6
	5-2	Brown Glass Packaging	0.1	0.0	0.2	0.1
	5-3	Other Glass Packaging	0.2	0.2	0.3	0.2
	5-4	Miscellaneous Non Packaging Glass	0.0	0.0	0.0	0.0
Textiles	6-1	Clothes	0.0	0.0	0.0	0.0
	6-2	Non-clothing textiles	0.0	0.0	0.0	0.0
Metals	7-1	Ferrous Packaging	0.1	0.1	0.1	0.1
	7-2	Miscellaneous Ferrous	0.1	0.0	0.1	0.1
	7-3	Aluminium Packaging	0.0	0.0	0.0	0.0
	7-4	Miscellaneous Non-ferrous	0.0	0.0	0.0	0.0
Hazardous Waste	8-1	Batteries/Accumulators	0.0	0.0	0.0	0.0
	8-2	Miscellaneous hazardous waste	0.0	0.1	0.1	0.1
Composites	9-1	Composite Packaging	0.1	0.2	0.2	0.2
	9-2	Composite Non-packaging	0.0	0.0	0.0	0.0
	9-3	WEEE	0.0	0.0	0.0	0.0
Other Categories	10-1	Soil and Stones	0.0	0.0	0.2	0.0
	10-2	Other inert	0.3	0.5	0.4	0.4
	10-3	Nappies	0.1	0.1	0.2	0.2
	10-4	Health Care/Biological Wastes	0.0	0.0	0.0	0.0
	10-5	Miscellaneous Categories	0.1	0.1	0.1	0.1
Fine fraction	11-1	10mm sieved fraction	0.4	0.4	0.4	0.4
Total			**5.8**	**5.2**	**7.1**	**5.8**

table 2-6: Waste amount per capita and week in summer [kg c^{-1} w^{-1}]

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	1.4	1.1	0.9	1.1
	1-2	Biodegradable Garden/Park Waste	0.1	0.1	0.4	0.2
	1-3	Other Biodegradable Waste	0.1	0.0	0.0	0.0
Wood	2-1	Wood untreated	0.2	0.1	0.1	0.1
	2-2	Wood treated	0.0	0.3	0.0	0.2
Paper/ Cardboard	3-1	Non-biodegradable paper	0.0	0.0	0.1	0.0
	3-2	Paper/cardboard – packaging	0.2	0.2	0.3	0.2
	3-3	Paper/cardboard– non packaging	0.1	0.1	0.2	0.1
	3-4	Newspapers	0.1	0.0	0.0	0.0
Plastics	4-1	Plastic Film – packaging	0.2	0.2	0.2	0.2
	4-2	Plastic Film – non packaging	0.1	0.0	0.1	0.0
	4-3	Dense Plastic – packaging	0.2	0.2	0.3	0.2
	4-4	Dense Plastic – non packaging	0.1	0.1	0.1	0.1
Glass	5-1	Clear Glass Packaging	0.2	0.3	0.3	0.3
	5-2	Brown Glass Packaging	0.1	0.0	0.1	0.1
	5-3	Other Glass Packaging	0.1	0.1	0.2	0.1
	5-4	Miscellaneous Non Packaging Glass	0.2	0.0	0.0	0.1
Textiles	6-1	Clothes	0.2	0.1	0.1	0.1
	6-2	Non-clothing textiles	0.1	0.0	0.0	0.1
Metals	7-1	Ferrous Packaging	0.0	0.0	0.0	0.0
	7-2	Miscellaneous Ferrous	0.8	0.0	0.0	0.2
	7-3	Aluminium Packaging	0.0	0.0	0.0	0.0
	7-4	Miscellaneous Non-ferrous	0.1	0.0	0.0	0.0
Hazardous Waste	8-1	Batteries/Accumulators	0.0	0.0	0.0	0.0
	8-2	Miscellaneous hazardous waste	0.0	0.0	0.0	0.0
Composites	9-1	Composite Packaging	0.1	0.1	0.1	0.1
	9-2	Composite Non-packaging	0.1	0.0	0.0	0.0
	9-3	WEEE	0.0	0.0	0.2	0.1
Other Categories	10-1	Soil and Stones	0.0	0.2	0.0	0.1
	10-2	Other inert	0.2	0.3	0.3	0.3
	10-3	Nappies	0.1	0.2	0.1	0.1
	10-4	Health Care/Biological Wastes	0.0	0.0	0.0	0.0
	10-5	Miscellaneous Categories	0.1	0.1	0.1	0.1
Fine fraction	11-1	10mm sieved fraction	0.2	0.1	0.2	0.2
Total			**5.6**	**4.2**	**4.6**	**4.6**

table 2-7: Total waste amount per capita and year [kg c^{-1} a^{-1}]

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	95.8	70.9	79.7	79.2
	1-2	Biodegradable Garden/Park Waste	6.8	3.8	12.2	6.4
	1-3	Other Biodegradable Waste	6.4	2.9	4.5	4.2
Wood	2-1	Wood untreated	5.0	2.9	3.2	3.5
	2-2	Wood treated	0.8	8.2	2.6	5.0
Paper/ Cardboard	3-1	Non-biodegradable paper	0.4	1.3	3.5	1.6
	3-2	Paper/cardboard – packaging	8.2	9.7	17.4	11.0
	3-3	Paper/cardboard– non packaging	4.5	8.4	18.9	9.7
	3-4	Newspapers	3.0	1.5	1.6	1.9
Plastics	4-1	Plastic Film – packaging	12.8	9.9	13.9	11.6
	4-2	Plastic Film – non packaging	2.8	2.0	2.8	2.4
	4-3	Dense Plastic – packaging	12.7	12.7	17.2	13.7
	4-4	Dense Plastic – non packaging	4.6	2.9	3.1	3.4
Glass	5-1	Clear Glass Packaging	23.7	19.3	27.7	22.3
	5-2	Brown Glass Packaging	4.2	2.3	7.7	4.0
	5-3	Other Glass Packaging	9.4	8.9	13.1	10.0
	5-4	Miscellaneous Non Packaging Glass	5.0	1.8	1.1	2.5
Textiles	6-1	Clothes	5.7	3.0	2.6	3.6
	6-2	Non-clothing textiles	3.5	1.9	0.8	2.1
Metals	7-1	Ferrous Packaging	3.1	3.1	2.7	3.0
	7-2	Miscellaneous Ferrous	25.7	1.5	1.9	7.8
	7-3	Aluminium Packaging	1.8	2.2	1.7	2.0
	7-4	Miscellaneous Non-ferrous	1.7	0.4	0.3	0.7
Hazardous Waste	8-1	Batteries/Accumulators	0.1	0.1	0.2	0.1
	8-2	Miscellaneous hazardous waste	0.4	1.6	3.1	1.6
Composites	9-1	Composite Packaging	5.2	6.9	6.6	6.4
	9-2	Composite Non-packaging	1.5	0.8	0.3	0.9
	9-3	WEEE	0.9	1.3	7.1	2.5
Other Categories	10-1	Soil and Stones	0.1	5.1	4.1	3.6
	10-2	Other inert	13.6	19.5	17.6	17.6
	10-3	Nappies	7.5	7.8	6.7	7.5
	10-4	Health Care/Biological Wastes	0.5	0.7	1.3	0.8
	10-5	Miscellaneous Categories	4.8	7.0	4.2	5.8
Fine fraction	11-1	10mm sieved fraction	14.5	13.5	13.4	13.7
Total			**296.7**	**245.6**	**305.0**	**272.0**

table 2-8: Annual waste composition of Khanty-Mansiysk

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	32.3%	28.8%	26.1%	37.8%	30.7%
	1-2	Biodegradable Garden/Park Waste	2.3%	1.5%	4.0%	0.4%	2.0%
	1-3	Other Biodegradable Waste	2.2%	1.2%	1.5%	2.8%	1.8%
Wood	2-1	Wood untreated	1.7%	1.2%	1.0%	2.2%	1.5%
	2-2	Wood treated	0.3%	3.3%	0.9%	0.0%	1.5%
Paper/ Cardboard	3-1	Non-biodegradable paper	0.1%	0.5%	1.1%	0.9%	0.6%
	3-2	Paper/cardboard – packaging	2.8%	3.9%	5.7%	7.5%	4.7%
	3-3	Paper/cardboard– non packaging	1.5%	3.4%	6.2%	9.7%	4.7%
	3-4	Newspapers	1.0%	0.6%	0.5%	1.0%	0.7%
Plastics	4-1	Plastic Film – packaging	4.3%	4.0%	4.6%	9.9%	5.2%
	4-2	Plastic Film – non packaging	1.0%	0.8%	0.9%	1.2%	0.9%
	4-3	Dense Plastic – packaging	4.3%	5.2%	5.6%	4.0%	4.9%
	4-4	Dense Plastic – non packaging	1.6%	1.2%	1.0%	1.9%	1.4%
Glass	5-1	Clear Glass Packaging	8.0%	7.9%	9.1%	4.5%	7.6%
	5-2	Brown Glass Packaging	1.4%	0.9%	2.5%	1.6%	1.5%
	5-3	Other Glass Packaging	3.2%	3.6%	4.3%	1.6%	3.3%
	5-4	Miscellaneous Non Packaging Glass	1.7%	0.7%	0.4%	0.0%	0.7%
Textiles	6-1	Clothes	1.9%	1.2%	0.9%	0.8%	1.2%
	6-2	Non-clothing textiles	1.2%	0.8%	0.3%	0.5%	0.7%
Metals	7-1	Ferrous Packaging	1.0%	1.3%	0.9%	0.6%	1.0%
	7-2	Miscellaneous Ferrous	8.6%	0.6%	0.6%	1.4%	2.6%
	7-3	Aluminium Packaging	0.6%	0.9%	0.6%	0.3%	0.7%
	7-4	Miscellaneous Non-ferrous	0.6%	0.2%	0.1%	0.0%	0.2%
Hazardous Waste	8-1	Batteries/Accumulators	0.0%	0.0%	0.1%	0.0%	0.0%
	8-2	Miscellaneous hazardous waste	0.1%	0.6%	1.0%	0.0%	0.5%
Composites	9-1	Composite Packaging	1.8%	2.8%	2.2%	1.7%	2.2%
	9-2	Composite Non-packaging	0.5%	0.3%	0.1%	0.2%	0.3%
	9-3	WEEE	0.3%	0.5%	2.3%	0.2%	0.8%
Other Categories	10-1	Soil and Stones	0.0%	2.1%	1.4%	2.3%	1.5%
	10-2	Other inert	4.6%	8.0%	5.8%	0.3%	5.4%
	10-3	Nappies	2.5%	3.2%	2.2%	0.6%	2.4%
	10-4	Health Care/Biological Wastes	0.2%	0.3%	0.4%	0.1%	0.3%
	10-5	Miscellaneous Categories	1.6%	2.9%	1.4%	0.6%	1.9%
Fine fraction	11-1	10mm sieved fraction	4.9%	5.5%	4.4%	3.2%	4.7%
Total			**100%**	**100%**	**100%**	**100%**	**100%**

table 2-9: Waste composition in winter period

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	39.5%	30.4%	29.7%	36.2%	33.0%
	1-2	Biodegradable Garden/Park Waste	2.7%	0.4%	0.3%	0.9%	1.0%
	1-3	Other Biodegradable Waste	3.1%	1.3%	1.8%	5.4%	2.4%
Wood	2-1	Wood untreated	0.0%	0.9%	0.8%	0.2%	0.6%
	2-2	Wood treated	0.1%	0.5%	1.3%	0.0%	0.5%
Paper/ Cardboard	3-1	Non-biodegradable paper	0.1%	0.4%	1.0%	1.2%	0.6%
	3-2	Paper/cardboard – packaging	1.4%	4.1%	5.1%	8.7%	4.3%
	3-3	Paper/cardboard– non packaging	1.1%	4.4%	7.4%	17.4%	6.1%
	3-4	Newspapers	1.0%	0.9%	0.5%	0.1%	0.7%
Plastics	4-1	Plastic Film – packaging	4.6%	3.7%	4.3%	5.1%	4.2%
	4-2	Plastic Film – non packaging	0.5%	1.1%	0.4%	1.6%	0.9%
	4-3	Dense Plastic – packaging	4.6%	5.6%	5.5%	5.0%	5.3%
	4-4	Dense Plastic – non packaging	0.5%	0.8%	0.7%	0.4%	0.7%
Glass	5-1	Clear Glass Packaging	11.9%	8.6%	10.2%	4.3%	9.2%
	5-2	Brown Glass Packaging	1.7%	0.8%	2.9%	0.0%	1.4%
	5-3	Other Glass Packaging	4.2%	4.0%	4.0%	1.4%	3.7%
	5-4	Miscellaneous Non Packaging Glass	0.4%	0.6%	0.2%	0.0%	0.4%
Textiles	6-1	Clothes	0.8%	0.8%	0.6%	0.3%	0.7%
	6-2	Non-clothing textiles	0.2%	0.5%	0.2%	0.1%	0.3%
Metals	7-1	Ferrous Packaging	1.3%	1.7%	0.9%	0.9%	1.3%
	7-2	Miscellaneous Ferrous	2.4%	0.6%	0.8%	1.2%	1.1%
	7-3	Aluminium Packaging	0.5%	0.8%	0.5%	0.3%	0.6%
	7-4	Miscellaneous Non-ferrous	0.0%	0.2%	0.1%	0.0%	0.1%
Hazardous Waste	8-1	Batteries/Accumulators	0.0%	0.0%	0.1%	0.0%	0.0%
	8-2	Miscellaneous hazardous waste	0.0%	1.0%	1.6%	0.0%	0.8%
Composites	9-1	Composite Packaging	2.2%	3.5%	2.3%	2.2%	2.7%
	9-2	Composite Non-packaging	0.0%	0.0%	0.0%	0.0%	0.0%
	9-3	WEEE	0.1%	0.4%	0.3%	0.4%	0.3%
Other Categories	10-1	Soil and Stones	0.0%	0.0%	2.2%	0.0%	0.6%
	10-2	Other inert	4.9%	9.1%	5.1%	0.1%	6.0%
	10-3	Nappies	2.6%	2.7%	2.5%	0.2%	2.3%
	10-4	Health Care/Biological Wastes	0.3%	0.3%	0.6%	0.2%	0.4%
	10-5	Miscellaneous Categories	0.9%	2.7%	0.8%	0.6%	1.6%
Fine fraction	11-1	10mm sieved fraction	6.4%	7.1%	5.1%	5.5%	6.2%
Total			**100%**	**100%**	**100%**	**100%**	**100%**

Table 2-10: Waste composition in summer period

1st Category	No	2nd Category	Small houses with a garden	Apartment blocks	Apartment blocks + business	Business	Total
Organics	1-1	Biodegradable Kitchen/Canteen Waste	24.7%	26.9%	20.6%	38.7%	28.1%
	1-2	Biodegradable Garden/Park Waste	1.9%	2.9%	9.9%	0.2%	3.2%
	1-3	Other Biodegradable Waste	1.2%	1.0%	1.0%	1.2%	1.1%
Wood	2-1	Wood untreated	3.4%	1.5%	1.5%	3.5%	2.4%
	2-2	Wood treated	0.5%	6.9%	0.1%	0.0%	2.6%
Paper/ Cardboard	3-1	Non-biodegradable paper	0.2%	0.7%	1.3%	0.7%	0.7%
	3-2	Paper/cardboard – packaging	4.2%	3.7%	6.6%	6.7%	5.0%
	3-3	Paper/cardboard– non packaging	1.9%	2.2%	4.3%	4.9%	3.1%
	3-4	Newspapers	1.1%	0.2%	0.6%	1.5%	0.8%
Plastics	4-1	Plastic Film – packaging	4.0%	4.5%	5.0%	12.8%	6.4%
	4-2	Plastic Film – non packaging	1.4%	0.4%	1.7%	1.0%	1.0%
	4-3	Dense Plastic – packaging	3.9%	4.6%	5.8%	3.5%	4.4%
	4-4	Dense Plastic – non packaging	2.7%	1.7%	1.5%	2.8%	2.1%
Glass	5-1	Clear Glass Packaging	3.9%	6.9%	7.3%	4.7%	5.7%
	5-2	Brown Glass Packaging	1.1%	1.1%	1.9%	2.5%	1.6%
	5-3	Other Glass Packaging	2.1%	3.1%	4.8%	1.7%	2.9%
	5-4	Miscellaneous Non Packaging Glass	3.1%	0.9%	0.7%	0.0%	1.2%
Textiles	6-1	Clothes	3.0%	1.7%	1.2%	1.1%	1.8%
	6-2	Non-clothing textiles	2.2%	1.1%	0.4%	0.8%	1.2%
Metals	7-1	Ferrous Packaging	0.8%	0.7%	0.9%	0.5%	0.7%
	7-2	Miscellaneous Ferrous	15.2%	0.7%	0.4%	1.5%	4.3%
	7-3	Aluminium Packaging	0.7%	1.0%	0.6%	0.4%	0.7%
	7-4	Miscellaneous Non-ferrous	1.2%	0.2%	0.0%	0.0%	0.3%
Hazardous Waste	8-1	Batteries/Accumulators	0.1%	0.0%	0.0%	0.0%	0.0%
	8-2	Miscellaneous hazardous waste	0.3%	0.1%	0.1%	0.0%	0.1%
Composites	9-1	Composite Packaging	1.3%	2.0%	1.9%	1.4%	1.7%
	9-2	Composite Non-packaging	1.1%	0.8%	0.3%	0.4%	0.7%
	9-3	WEEE	0.5%	0.7%	5.4%	0.0%	1.3%
Other Categories	10-1	Soil and Stones	0.0%	4.6%	0.0%	3.7%	2.5%
	10-2	Other inert	4.3%	6.6%	6.8%	0.4%	4.6%
	10-3	Nappies	2.5%	3.7%	1.7%	0.9%	2.4%
	10-4	Health Care/Biological Wastes	0.0%	0.3%	0.1%	0.1%	0.1%
	10-5	Miscellaneous Categories	2.3%	3.1%	2.3%	0.6%	2.2%
Fine fraction	11-1	10mm sieved fraction	3.3%	3.5%	3.4%	1.7%	3.0%
Total			**100%**	**100%**	**100%**	**100%**	**100%**

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Part B - Data and information about infrastructure and

Part C - Existing waste management structure in Khanty-Mansiysk

Part D - Waste generation and prognosis

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