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Feasibility Study
for the Integrated Waste Management System in Waste Management Zone 8, North Development Region

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Acronyms and abbreviations

CDW	Construction and demolition waste
CLO	Compost Like Output
DPC	Dynamic Prime Costs
ETWDS	Enhanced Transitional Waste Disposal Site
EU	European Union
EUR	Euro, currency
GCL	Geo-synthetic Clay Liner
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
Ha	Hectares
HDPE	High-Density Polyethylene
IDA	Intercommunity Development Association
IWMS	Integrated Waste Management System
JSC	Joint Stock Company
LDPE	Low Density Polyethylene
LPA	Local Public Authority
MBT	Mechanical Biological Treatment
MDL	Moldovan Lei, currency
ME	Municipal Enterprise
MLPS	Modernisation of Local Public Services in the Republic of Moldova
MoEco	Ministry of Economy
MoEnv	Ministry of Environment
MoF	Ministry of Finance
MoH	Ministry of Health
MoU	Memorandum of Understanding
MRDC	Ministry of Regional Development and Construction
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
NBS	National Bureau of Statistics of the Republic of Moldova
NPV	Net Present Value
NWMS	National Waste Management Strategy
PET	Polyethylene Terephthalate
PWG	Project Working Group
RDA	Regional Development Agency
RM	Republic of Moldova
CDR	Centre Development Region
WMZ 5	Waste Management Zone 5 (Ungheni, Calarasi and Nisporeni rayons)

1 Introduction

Since 2010 and until present the German Development Cooperation through GIZ implements the project, **„Modernization of Local Public Services" (MLPS).** Institutional partner of the project is the Ministry of Regional Development and Construction (MRDC), and key stakeholders that assure implementation of the project are the three Regional Development Agency Centre, North and South.

The overall objective of the project is to improve local public services in the Republic of Moldova by providing support to regional and local stakeholders in order to connect the local needs to regional and national priorities. MLPS covers two interventions areas:

- Intervention Area 1: Providing local public services – support to RDAs and LPAs in planning, development, implementing and managing pilot projects in order to improve local public services;
- Intervention Area 2: Regional planning and programming – support to RDAs and LPAs in regional planning and programing.

Within Intervention Area 2 „Regional planning and programming", MLPS project has provided support to improve regional sector planning and programming in waste management sector for Centre and North Development Regions. Thus, during 2012-2013 within project were elaborated Regional Sector Programmes on Solid Waste Management for North and Centre Development Regions. The Programmes were approved in February 2014 by respective Regional Development Council.

In Development Region South, MLPS project assessed the compatibility of the Solid Waste Management Strategy in South Development Region to MLPS project requirements, and later on was initiated the development of the **Feasibility Study for the integrated solid waste management system for waste management zone 3 (Cahul, Cantemir, Taraclia Vulcanesti** and **Ceadir – Lunga rayons**)**, South Development Region**". This zone is waste management zone 1 (WMZ 1) according to the Waste Management Strategy in the Republic of Moldova for 2013-2027.

Parallel with the development of the Feasibility Study for WMZ 1, it was started the development of the Feasibility Studies for another two zones:

- Feasibility Study for the integrated solid waste management system for waste management zone 5 – WMZ 5 (Ungheni, Calarasi and Nisporeni rayons), Center Development Region;
- Feasibility Study for the integrated solid waste management system for waste management zone 8 – WMZ 8 (Edinet, Briceni, Ocnita and Donduseni rayons), North Development Region.

The current document represents the **Feasibility Study for the integrated solid waste management system for waste management zone 8** and comprises the following sections:

- Baseline conditions (section 2);
- General legislative framework (section 3);
- Current situation on municipal waste generation and forecast (section 4);
- Current situation on municipal waste management (section 5);
- Management of special waste streams: hazardous household waste, bulky waste, packaging waste, waste electrical and electronic equipment, waste batteries and accumulators, construction and demolition waste (section 6);
- Objectives and targets (section 7);
- Option analysis (section 8);
- Closure of the existing dumpsites (section 9);
- Design parameters for the integrated waste management system (section 0);
- Project description (section 11);
- Financial and economic analysis (section 12);
- Risk analysis (section **Error! Reference source not found.**);
- Institutional arrangements (section 14);
- Socio-economic impact and gender aspects (section 15);
- Environmental impact (section 16);
- Procurement strategy and implementation plan (section 17).

The proposed system through the Feasibility Study will assure the management of municipal waste from the zone, which includes the collection, transport, transfer, treatment and disposal of the waste in a regional landfill.

For the elaboration of the Feasibility Study the current national legislation and the relevant European directives were taken into consideration.

During the elaboration of the feasibility study, additional activities were also carried out, namely:

- Making **Memoranda** regarding the elaboration of the Feasibility Study and the Environmental Impact Assessment in order to set up the Integrated Waste Management System in WMZ 5, and in WMZ 8. The Memoranda were made between the Ministry of Regional development and Constructions, the Ministry of the Environment, The Regional Development Agency, level II local public authorities (Rayon Councils) and level I local public authorities (town halls where waste management plants are going to be built), and GIZ. These Memoranda include the obligations of each party and the action plan regarding the process of drawing up the Feasibility Study and the Environmental Impact Assessment procedure;

- Approval the **Regulation on the setting up and the operation of the Local Steering Committee** elaborating the Feasibility Study and the Environmental Impact Assessment for the Integrated Waste Management System in WMZ 5, and in WMZ 8. The Local Steering Committee represents the main collaboration platform for all the parties during the elaboration of the Feasibility Study and the Environmental Impact Assessment procedure. The first meeting of the Committees is scheduled for January 2017;

- **Three meetings of the Local Steering Committees for Integrated Waste Management System in WMZ 8** took place: on 24.01.2017, 03.04.2017, and 16.05.2017). During the meetings the draft and final results of the feasibility study were presented and discussed with the stakeholders.

2 Baseline conditions

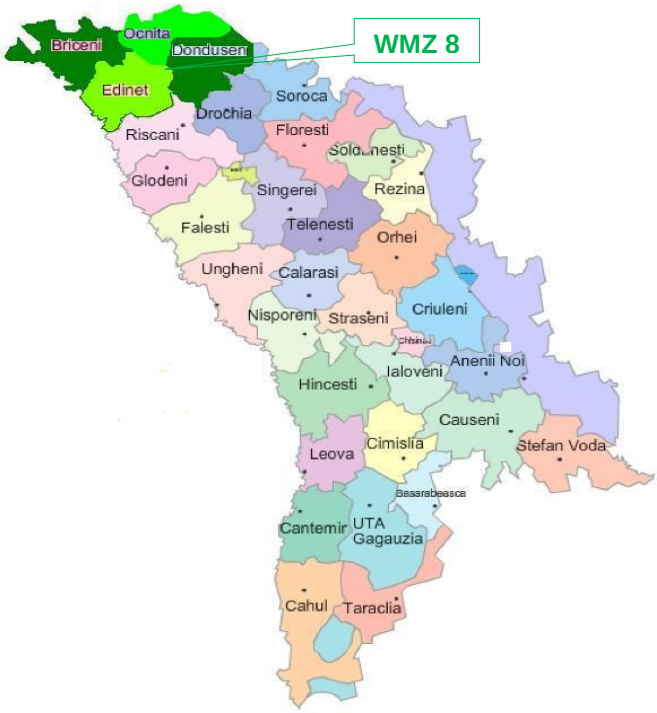
2.1 Geographical context

Waste Management Zone 8 (WMZ 8) consists of four rayons - Briceni, Donduşeni, Edineţ and Ocniţa, located compactly in the north part of the country.

WMZ 8 is bordered with Romania in the direction North-West and with Ukraine in the direction North-Est. In the south part the WMZ 8 has administrative borders with rayons Soroca, Drochia and Rîşcani.

The WMZ 8 is located in the area with high potential development, on the crossroads of major transport corridors. From northwest to southeast the WMZ 8 territory is crossed by a road of international importance M14 (Brest-Briceni-Chisinau-Tiraspol-Odessa). The territory of the WMZ 8 is crossed also by roads of national importance such as - R9, R10, R11, R12, R45 and R51.

Figura 2-1: Geographical position of the WMZ 8 rayons



Source: GIZ/MLPS

All four rayons belong to the North Development Region (NDR) of Moldova. Edineţ, Ocniţa and Briceni rayons are part of the "Upper Prut" European region, while Donduşeni and Ocniţa represent the European region "Nistru".

The geographical position of WMZ 8 favors access, communications and trans-border trade with Romania as a European Union country and Ukraine.

The average distance between towns of Ocniţa, Donduşeni, Edineţ and Briceni is about 55 km. The distance from these towns to the capital city – Chisinau vary from 210 km in case of the closest one Edineţ to 242 km in case of the most far one – Briceni.

Table 2-1: Distance between centers of WMZ 8 rayons and the capital city Chisinau, km

	Ocniţa	Donduşeni	Edineţ	Briceni	Bălţi	Chisinau
Ocniţa	-	44	35	40	98	238
Donduşeni	44	-	37	63	76	216
Edineţ	35	37	-	30	70	210
Briceni	40	63	30	-	102	242
Bălţi	98	76	70	102	-	136
Chisinau	238	216	210	242	136	-

Source: GIZ/MLPS

Relief

In terms of geographical location WMZ 8 is located on the Northern Moldova Plateau.

The relief is mostly a hilly plain, strongly dismembered by valleys with a general incline from the Northwest to the Southeast. The maximum altitude (259 m) is located close to the Lipnic village of the Ocniţa rayon. The relief of WMZ 8 is strongly influenced by soil erosion processes and landslides that create conditions for the formation of ravines and gullies that bring damage primarily to agriculture through destroying and removing from use the fertile soil. According to the relief the territory of WMZ 8 can be classified as forest steppe zone.

Climate

The climate in the WMZ 8 is temperate continental, with hot and dry summers and cool winters. Average annual precipitation ranges from 520-620 mm. The average annual temperature is 8 degrees.

The absolute minimum of the temperature recorded is minus 36^0C and the average temperature in January is minus 5^0C degrees. The maximum temperature recorded is 38^0C and the average temperature in July is the 20^0C degree. The annual amount of precipitation is about 600 mm/m^2 with the maximum in June of cca. 89 mm/m^2 and the minimum in February - cca. 23 mm/m^2. Most frequent winds are from the direction of northwest and southeast.

Climatic conditions in the WMZ 8 are favorable for growing cereals, sugar beet, sunflower, tobacco and fruit trees. Another feature of the climate in the WMZ 8 is the high frequency of flooding, excessive rainfalls and landslides.

Area and soils

The total area of WMZ 8 is about 2.9784 sq. km, of which Briceni rayon - 772 sq. km, Donduşeni rayon – 801 sq. km, Edineţ rayon – 795 sq. km and Ocniţa - 616 sq. km. The area of WMZ 8 rayons is quite uniform. The share of each rayon in the total area of the WMZ 8 vary from 21% to 27%. The largest rayon of WMZ 8 is Donduşeni with a share of cca. 27% of

WMZ 8. The total area of WMZ 8 accounts for about 9% of the total area of the Republic of Moldova of 33.846 sq. km.

Table 2-2: Area of rayons in the WMZ 8, 2016, sq. km

Rayons / WMZ 8	Area, sq. km.	Share of total area of WMZ 8 (%)	Share of total area of the RM (%)
Briceni	771.7	25.9	2.3
Donduşeni	801.4	26.9	2.4
Edineţ	795.2	26.6	2.3
Ocniţa	615.7	20.6	1.8
WMZ 8	**2,984.0**	**100.0**	**8.8**

Source: GIZ/MLPS, calculations based on NBS 2017 data

The soils of the territory of WMZ 8 are characterized by high fertility. Most part of the pedological profile is constituted from chernozems. The average quality of soils in the WMZ 8 is 72 points (out of 100), the average value per republic being of 63 points. These soil characteristics allow obtaining high harvests of technical agricultural crops.
In the same time soils of the territory of WMZ 8 are undergoing a process of losing soil nutrients due to erosion in dry years when there is a rapid decomposition of organic matter and slowing the process of humus creation due to the high temperatures and lack of moisture. It can be said that soils of WMZ 8 are in a constant state of degradation, impoverishment, state which naturally is reflected on the agricultural sector.
Soils in WMZ 8 are also subject to ongoing pollution process. Among the main sources of soil pollution can be mentioned: wastewater pollution, unauthorized and non-compliant landfills and improper discharge of domestic waste and sewage in the localities and institutions on the territory of WMZ 8.

Hydrography

The hydrological network of WMZ 8 includes the Prut River, which is the natural border to the west and the Dniester River that is the largest water flow in the area. Prut River Basin tributaries in WMZ 8 includes: a) Ciuhur, b) Racovăţ, c) Larga, d) Vilia, e) Draghişte, f) Bogda, g) Sarata and h) Lopatinca.
The Racovăţ river, which springs near the village Serbeni located in the Chernivtsi region of the Ucraine and flows into the Prut river close to the village Corpaci since the year 2000 serves as a source of centralized drinking water supply for towns of Edineţ and Cupcini.
Apart from rivers, a large number of lakes or ponds exists in all WMZ 8 rayons. The largest area of lakes is in the Edineţ rayon – 1,600 ha. Almost all lakes belong to the state enterprises and to local public administration.

Table 2-3: Area covered by lakes in WMZ 8 according to forms of proprietorship, 2013, ha

	Donduşeni	Briceni	Edineţ	Ocniţa	Total WMZ 8
Total area of lakes	849	1,203	1,600	825	4,476
State owned	74	360	1,019	105	1,558
Owned by LPAs	775	843	581	719	2,918
Private ownership	0	0	0	1	1

Source: GIZ/MPLPS, calculations based on National Cadastre 2013 data

The main sources for water supply of lakes are precipitation and groundwater sources. The water level in lakes depends on the season. During the summer the water level drops. Some lakes are used as a source for irrigation of agricultural land. The major problems facing the maintenance and use of lakes in WMZ 8 rayons are related to the water pollution above admissible concentrations and intensive development of soil erosion processes that leads to the accelerated silting of existing lakes and pounds.

2.2 Socio-economic data

2.2.1 Settlements

The four rayons included in the WMZ 8 comprise eight towns and 143 villages. Out of the total number three towns (Ocniţa, Otaci and Frunză) are located in the Ocniţa rayon. Edineţ and Briceni rayons have two towns each: Edineţ and Cupcini, and Briceni and Lipcani, respectively, and Donduşeni rayon the town of Donduşeni.

Villages in WMZ 8 area are organized into 95 communes. The largest number of villages (49 units) is in the rayon Edineţ (47 villages), followed by Briceni (37 villages), Ocniţa (30 villages) and 29 villages are located in the Donduşeni rayon.

Table 2-4: Number of localities in the rayons of WMZ 8 and RM, 2016

	Ocniţa	Donduşeni	Edineţ	Briceni	Total in WMZ 8	Republic of Moldova, without Transnistria
Cities	3	1	2	2	8	52
Villages in the frame of cities	0	0	4	0	4	39
Villages with administrative council	18	21	30	26	95	846
Villages in the frame of communes	12	8	13	11	44	593
Total	**33**	**30**	**49**	**39**	**151**	**1,530**

Source: NBS, 2017

2.2.2 Gross domestic product

Current situation

Official statistical sources do not provide data on GDP at the rayon level. However, starting with 2016 the National Bureau of Statistics started to analyze the regional aspect of the GDP as well. Thus the 2016 issue of the National Accounts published by the National Bureau of Statistics contains data concerning the volumes of GDP at the level of North, Centre and South regions for years 2013 and 2014[1]. The Chisinau municipality is obviously the pole of economic development in the country that produces more GDP than all regions together. The North region is the second important development region that contributed to about 18% of the total country GDP in 2014. Also according to the per capita GDP the North region is on

[1] NBS (2016) Conturi Naţionale 2015 / National Accounts 2015. Accessed at: http://www.statistica.md/public/files/publicatii_electronice/Conturi_nationale/Conturi_nationale_2015.pdf

the second position after the Chisinau municipality with about 21 thous. MDL in 2014 that is considerably higher than in the Centre and South regions (see table 2-5)

Table 2-5: Regional GDP (total and per capita), current prices, thousand MDL, 2013-2914

Regions	Regional GDP		Regional GDP per capita	
	2013	2014	2013	2014
Chişinău municipality	56,038,053	62,869,976	69.8	77.9
North	18,381,911	20,519,025	18.4	20.7
Centre	15,964,951	17,973,693	15.1	17.0
South	9,001,710	9,704,175	6.8	18.1
UTA Găgăuzia	2,834,781	3,064,634	17.5	18.9

Source: NBS 2016

Forecast

As starting values point for calculation of the GDP forecasts per rayons were used GDP per capita values of the year 2014 at the region level.
The value of the per capita GDP for the year 2014 was calculated in USD using the average annual exchange rate of the National Bank of Moldova equal to 14.0388 MDL[2].
The most appropriate methodology of GDP calculation at the rayon level consist on calculation of the per capita GDP for a certain year and multiplying this value with the number of present population of this rayon for the given year. This method seems to be more appropriate also because of the availability of the population forecast for the period 2015-2040.
The differences between GDP per capita in rural and urban areas, are considered insignificant at the rayon level.
The official data about prognoses for the GDP growth in the proximate future shows a figure of 3-4% annual growth rate[3]. In our forecast we took a moderate growth rate of about 2% per year.
Given these assumptions we received a 28% increase of GDP in WMZ 8 rayons during the period 2015-2040, from cca. 337 mil. USD in 2015 to about 433 mil USD in 2040 .

Table 2-6: GDP forecast for WMZ 8 in current prices 2015-2040, Mil. USD

Rayons/WMZ 8	2015	2020	2025	2030	2035	2040
Briceni rayon	104	109	114	120	126	134
Donduşeni rayon	56	58	61	64	68	72
Edineţ rayon	107	112	117	123	129	137
Ocniţa rayon	70	73	77	81	85	90
Total WMZ 8	337	353	370	388	408	433

Source: GIZ/MLPS, calculations based on NBS 2017 data

[2] NBM (2017). Accessed at: http://www.bnm.org/ro/content/ratele-de-schimb
[3]Ministry of Finances (2014) Cadrul bugetar pe termen mediu pe anii 2015-2017. Accessed at: http://mf.gov.md/files/files/Acte%20Legislative%20si%20Normative/CBTM/2015%20-%202017/Cadrul%20bugetar%20pe%20termen%20mediu%202015-2017.pdf

2.2.3 Economic profile of the area

The economy of WMZ 8 rayons follows, with small deviations, the same pattern as all rayons of the North Development Region and is based mostly on agriculture and processing industry. The agricultural sector provided about 25% of the regional Gross Value Added, while the processing industry contributed with about 13% of GVA in 2014. In the year 2014 the share of agriculture decreased comparing with the previous year, while the share of the processing industry increased.

Table 2-7: GDP structure for NDR, 2013-2014, %

	2013	2014
Agriculture, forestry and fishery	23.8	25.0
Processing industry	11.9	13.1
Trade	8.2	8.5
Real estate transactions	4.0	4.1
Transport and warehousing	4.7	4.9
Other sources	31.0	28.9
Total gross value added	83.6	84.6
Net taxes on products	16.4	15.4
Total regional GDP	100.0	100.0

Source: GIZ/MLPS, calculations based on NBS 2016 data

The most economically developed rayon in WMZ 8 is the Edineţ, where is located the largest part (45%) of all 6,344 enterprises registered in WMZ 8 by the end of the 2016. This rayon is followed at a certain distance by Ocniţa with 24%, Briceni (21%) and Donduşeni rayon with just 9% of all enterprise registered in WMZ 8.

More than 62% of all registered enterprises in WMZ 8 have the legal form of “Individual enterprise”. The second wide-spread legal form of enterprises utilized in WMZ 8 rayons is “Limited Liability Company” with a shear of about 30%. The other legal forms of the enterprises constitute about 8% of all enterprise registered in the WMZ 8.

Table 2-8: Distribution of the registered enterprises by legal form, 2016

Legal form	Edineţ rayon	Ocniţa rayon	Briceni rayon	Donduşeni rayon	WMZ 8
Individual enterprises	1,783	963	898	307	3,951
LLC	907	459	349	192	1,907
Joint stock companies	38	25	8	10	81
Coops & Associations	117	82	50	74	323
Other forms	35	24	17	6	82
Total	2,880	1,553	1,322	589	6,344

Source: GIZ/MLPS calculations, based on data.gov.md

Per total in WMZ 8 registered enterprises are distributed quiet even in urban (45%) and rural (55%) areas with a small dominance of the rural area. However in the most economically developed rayons, namely in Edineţ and Ocniţa one can observe a clear dominance of the enterprises registered in the urban area. Especially this refers to individual enterprises, limited liability companies and joint stock companies. In the same time cooperatives, municipal enterprises, credit and savings associations and associations of peasant farms are located predominantly in the rural area.

Table 2-9: Distribution of the registered enterprises by legal form, 2016

Legal form	Edineţ rayon		Ocniţa rayon		Briceni rayon		Donduşeni rayon		WMZ 8	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Individual enterprises	60	40	59	41	4	96	14	86	43	57
LLC	67	33	63	37	16	84	18	82	51	49
Joint stock companies	76	24	68	32	38	63	40	60	65	35
Coops & Associations	38	62	48	52	6	94	12	88	29	71
Other forms	60	40	88	13	18	82	0	100	55	45
Total	61	39	60	40	7	93	15	85	45	55

Source: GIZ/MLPS, calculations, based on data.gov.md

Industry

Due to specific local conditions WMZ 8 rayons are specialized predominantly in the in agro-food processing sector and particularly in sugar production. Thus in WMZ 8 are located two important sugar factories in Donduşeni and “Cristal Sugar” in Cupcini. In tWMZ 8 is located one of the most important dairy factories in Moldova namely the S.A. „Inlac” from Cupcini. Another important sector is cereal collection and processing represented by such factories as “Cereale-Lipcani”, “Combifuraj-Corjeuti”, “Cereale-Cupcini”, “Cereale-Rediul Mare”, “Cereale-Roada” from Otaci, etc.

In Cupcini activates one of the largest fruit and vegetable processing factory in the republic - “Natur Bravo”. Tobacco processing is represented by “Nord Tutun” factory from Cupcini. The industrial sector of WMZ 8 rayons is represented also by chemical industry, production of furniture, bakery, garments, sausages production, etc.

The raw material for the S.A. „CMC-KNAUF” from Bălţi is extracted from the gypsum quarry near the village Criva, Briceni. In the WMZ 8 rayons minerals such as crushed stone, gravel, pebbles and stone are mined as well.

A free economic zone FEZ Otaci-Business have been created in the rayon Ocniţa within an area of 32.2 hectares, and which includes 12 residents. In Edineţ rayon activates an industrial park PP "Edineţ" with an area of 18.6 hectares.

The value of the manufactured production in tWMZ 8 rayons reached 1,046 mil MDL in 2015 and constituted about 2% of the total value of the manufactured production in the RM and about 12% the total value of the manufactured production in NDR.

Agriculture

One of the most important economical sector in WMZ 8 is agriculture. The typical feature of the North region is the high share of land involved in agricultural activities. Thus on average in the WMZ 8 about 79% of the land is used for agricultural activities, including in Donduşeni rayon – 82%, in Edineţ rayon – 80%, and in Briceni and Ocniţa rayons - 76%. The largest part of the agricultural land is used as arable land. The share of the arable land in total area varies from 56% in Ocniţa rayon to 64% in Edineţ rayon.

The most important field crops are maize, wheat, sun flower, barley and sugar beet. Important areas are occupied by perennial plantations, especially apples. Orchards cover from 5 to 9% of the total agricultural land in the WMZ 8 rayons. Another peculiarity of the

WMZ 8 rayons is that about 11% of the total agricultural land is occupied by pastures and meadows. This creates good conditions for livestock production in this area.
The WMZ 8 rayons belong to some of the less forested rayons in the republic. Thus forests cover only 9% of the total area of Donduşeni and Edineţ rayons, 12% in Briceni rayon and 14% in Ocniţa rayon. On average about 11% of the total land area in WMZ 8 is covered by forest plantations. Only about 2% of the total land area in WMZ 8 is covered by water and wet areas.

Table 2-10: Land structure in WMZ 8 rayons, %, 2012

	Edineţ rayon	Briceni rayon	Donduşeni rayon	Ocniţa rayon	WMZ 8
Total agricultural land	80	76	82	76	79
Arable land	64	60	59	56	60
Perennial plantations	5	8	9	9	7
Pastures	11	9	14	11	11
Forests	9	12	9	14	11
Land under water	2	3	2	2	2
Ravines and landslides	1	1	1	0	1
Roads	2	2	2	3	2
Streets and squares	2	2	1	2	2
Constructions and courts	4	3	2	3	3
Other land	5	1	3	0	3
Total area	**100**	**100**	**100**	**100**	**100**

Source: GIZ/MLPS, calculations based on National Cadastre 2012 data

The largest area of agricultural land is in Edineţ rayon – 74,4 thousand ha. At a certain distance it is followed by Briceni rayon – 62.2 thousand ha, Donduşeni – 52.3 thousand ha, and Ocniţa rayon with 45,3 thousand ha. Per total in WMZ 8 about 234.7 thousand hectares of land are involved in agricultural activities.
Most of the agricultural land in WMZ 8 is privately owned. On average about 83% of agricultural land in WMZ 8 is under private proprietorship, with variations from cca 80% in Donduşeni rayon to cca. 87% in Briceni rayon. Local Public Authorities (LPA) own on average about 15% of agricultural land in the WMZ 8 rayons with variations from circa 11% in Briceni rayon to about 18% in Donduşeni rayon. The share of the state owned agricultural land is about 2 in the WMZ 8.

Table 2-11: Structure of the agricultural land, %, 2012

Indicator	Edineţ rayon	Briceni rayon	Donduşeni rayon	Ocniţa rayon	WMZ 8
State owned agricultural land	3	2	2	1	2
Agricultural land owned by LPA	15	11	18	15	15
Private agricultural land	82	87	80	84	83
Total agricultural land	**100**	**100**	**100**	**100**	**100**

Source: GIZ/MLPS, calculations based on National Cadastre 2012 data

The landscape, soil and climate conditions conditioned also the specialization of the WMZ 8 rayons in field crops and apple production. Thus the average yield of crops such as maize, wheat, sunflower and barley is considerably higher in all WMZ 8 rayons comparing with the average level per country. The same is available for apple production. The only exception is

Ocniţa rayon where the average yield of apples per hectare is lower than the average per Republic of Moldova.

Table 2-12: Average yields per hectare for most important crops, tonnes / ha, 2015

	Ocniţa rayon	Donduşeni rayon	Edineţ rayon	Briceni rayon	Average in the R. Moldova
Maize	**2.46**	**2.56**	**2.61**	**2.87**	**2.14**
Wheat	**3.52**	**3.50**	**3.33**	**3.60**	**2.76**
Sun flower	**1.85**	**1.54**	**1.65**	**1.66**	**1.55**
Barley	**2.99**	**2.96**	**2.76**	**3.23**	**2.29**
Fruits	**5.12**	**6.49**	**8.90**	**10.84**	**5.80**

Source: GIZ/MLPS, calculations based on NBS 2016 data

Livestock production in WMZ 8 rayons is well developed and especially the milk production sector. The average annual milk yield per cow in Ocniţa rayon in 2015 was almost twice higher comparing with the average level in other rayons of WMZ 8 or in other regions of the Republic of Moldova. The average annual egg production per good layer in Donduşeni and Briceni rayons is about 30-40% higher comparing with other regions of the Republic of Moldova. The bovine daily weight gain in Ocniţa rayon in 2015 was higher than the average level in the North Development region. In the same time the swine daily weight gain is considerably lower comparing with other regions of the Republic of Moldova. All these figures shows a picture of a well developed livestock sector in WMZ 8 specialized in cattle raising, milk and egg production based on certain competitive advantages of the cattle breeding in WMZ 8 rayons.

Table 2-13: Livestock production indicators, 2015

	Edineţ rayon	Donduşeni rayon	Ocniţa rayon	Briceni rayon	NDR	CDR	SDR
Bovine daily weight gain (gr.)	246	235	369	56	340	389	417
Swine daily weight gain (gr.)	83	75	131	149	211	479	226
Average annual milk yield per cow (kg)	3,131	2,582	6,495	3,078	3,736	3,013	3,422
Average annual egg production per good layer (piece.)	69	256	0	260	190	177	213

Source: GIZ/MLPS, calculations based on NBS 2016 data

However, as it is typical for the Republic of Moldova, the largest part of the agricultural sector is represented by small-scale households both in vegetal production and animal breeding.

Services

The service sector is developed quite uneven in different rayons of WMZ 8. Edineţ rayon is leading according to the volume of turnover in the service sector (2537 mil. MDL) comparing with other WMZ 8 rayons, but also according to the share of the turnover from service activities (72%) in total volume o the turnover in the rayon. The lowest volume of turnover in the service sector (228 mil. MDL) comparing to WMZ 8 rayons, and the lowest share of the turnover from service activities (39%) was registered in 2015 in Ocniţa rayon.

Table 2-14: Turnover per sectors in WMZ 8 rayons, 2014, mil MDL, %

Rayons/ WMZ 8	Agriculture		Industry		Services		Total	
	Mil. MDL	%	Mil. MDL	%	Mil. MDL	%	Mil. MDL	%
Edineţ	422.1	11.9	574.5	16.3	2,536.7	71.8	3,533.4	100.0
Donduşeni	458.6	31.0	10.5	0.7	1,009.7	68.3	1.478.7	100.0
Briceni	284.8	33.6	83.2	9.8	480.7	56.6	848.7	100.0
Ocniţa	236.1	39.9	127.3	21.5	228.0	38.6	591.4	100.0
Total WMZ 8	1,401.6	21.7	795.4	12.3	4,255.1	65.9	6,452.2	100.0

Source: GIZ/MLPS, calculations based on NBS 2016 data

The most important sub-sector of the service sector is the "Wholesale and retail trade" that contributes to the largest part of the service sector turnover in three of four WMZ 8 rayons. The only exception is the Donduşeni rayon where the largest part of the service sector turnover is assured by the sub sector of "Energy, heating, gas and water supply" that contributed with a share of 47.7% of the turnover in the service sector in the year 2015 that is just almost equal with the share of the "Wholesale and retail trade" – 47.4%. The other important service sub-sectors are "Transport and warehousing" and "Constructions".

Hotel activity is not so developed in WMZ 8 rayons. Thus in the year 2015 in Edineţ have been only 89 hotel rooms, in Donduşeni – 47 rooms, in Briceni – 32 rooms and in the Ocniţa rayon only 25 hotel rooms that is among the lowest indicators in the republic.

Table 2-15: Structure of the turnover in the service sector of WMZ 8 rayons, 2015, %

	Briceni rayon	Donduşeni rayon	Edineţ rayon	Ocniţa rayon
Wholesale and retail trade	77.5	47.4	82.0	89.8
Energy, heating, gas and water supply	1.6	47.7	8.3	2.8
Transport and warehousing	13.9	4.7	2.2	5.9
Constructions	6.3	nd	4.4	nd
Other services	0.7	0.1	3.1	1.5
Total	100.0	100.0	100.0	100.0

Source: GIZ/MLPS, calculations based on NBS 2016 data

Transport infrastructure

The most important part of the transport infrastructure is assured by roads. The area of WMZ 8 is crossed by a road of international importance M14 (Brest-Briceni-Chisinau-Tiraspol-Odessa). The territory of the WMZ 8 is crossed also by roads of national importance such as - R9, R10, R11, R12, R45 and R51.

The road network that crosses the area of WMZ 8 is quite extensive and reach the length of about 1069 km, of which the largest portions belongs to the Edineţ rayon (327 km) and Briceni rayon (321 km). The share of national roads in total length of roads varies from 43% in Ocniţa to 19% in Edineţ, while in Briceni and Donduşeni this indicator is of 23% and 28%,

respectively. The whole length of the national roads is covered with rigid pavement, while in case of local roads the best situation is in the Ocniţa rayon where about 100% of all local roads are covered with rigid pavement. In Edineţ rayon this indicator is 97%, in Briceni – 94% and in the Donduşeni rayon - 91%.

Table 2-16: The length and structure of the public roads in WMZ, 2015, km

Rayons/ WMZ 8	Total roads	National roads	thereof with rigid pavement	Local roads	thereof with rigid pavement
Briceni	320.7	72.5	72.5	248.2	233.2
Donduşeni	210.4	58.2	58.2	152.2	138.5
Edineţ	326.7	62.3	62.3	264.4	256.3
Ocniţa	211.3	90.2	90.2	121.1	120.8
Total WMZ 8	**1,069.1**	**283.2**	**283.2**	**785.9**	**748.8**

Source: GIZ/MLPS, calculations based on NBS 2016 data

The second important transport infrastructure is railways sector that connects the Ocniţa town in direction Kamianets Podilski and Mogiliov Podilsk, and the Lipcani town in the direction Cernautsi of Ucraine.

2.2.4 Population

Current situation

To assess the demographic trends in WMZ 8 rayons the present population indicators were used. This was done because according to the methodological notes of the NBS the present population refers to the number of persons present at the Census moment, including temporarily resident persons while the resident population refers to the number of persons, permanently residents on the given territory, including the persons temporarily absent. For this reason the number of present population gives a more real picture of the inhabitants of the certain territory.

According to the most recent NBS data the number of the present population in the WMZ 8 rayons on January 1, 2015 amounted to 223,682 persons, of which in Briceni rayon – 69,217 persons, in Donduşeni rayon – 37,021 persons, in Edineţ rayon – 70,937 persons and in the Ocniţa rayon – 46507 persons. The population of WMZ 8 constituted about 8.0 % of the Republic of Moldova's population on 1 January 2015.

On average in the WMZ 8 only about 24% of the total population lives in urban area, the other 76% being rural inhabitants. The highest share of urban population was registered in Edineţ rayon - approx. 32%, and the lowest in Briceni rayon - approx. 17%. In Ocniţa and Donduşeni rayons this indicator is 29% and 19%, respectively. For comparison on average in the Republic of Moldova about 34% of population lives in urban and other 66% in rural areas. The average population density in WMZ 8 is approx. 75 persons per square km, including Briceni rayon - 85 persons, Donduşeni rayon - 57 persons, Edineţ rayon - 76 persons and Ocniţa rayon - 78 persons per square km. The density of population in the Briceni rayon is higher than the average level in the Republic of Moldova, while in other three rayons this indicator is considerably lower than the average population density in the Republic Moldova of about 83 persons per square km.

Table 2-17: Socio-demographic indicators in the RM and WMZ 8 rayons, 2015

Indicators	Briceni rayon	Donduşeni rayon	Edineţ rayon	Ocniţa rayon	WMZ 8	RM
Area (sq. km)	814.4	644.1	932.9	597.5	2,989	33,846
Population	69,217	37,021	70,937	46,507	223,682	2,804,801
Urban population	11,755	6,832	22,359	13,559	54,505	950,994
Density of population (pers./sq.km)	85	57	76	78	75	83
Share of urban population (%)	17.0	18.5	31.5	29.2	24.4	33.9

Source: GIZ/MLPS, calculations based on NBS 2016 data

Demographic trends in the project area shows a continued decrease of population during the last years. Thus, in 2015 compared to 2009 the number of the present population of WMZ 8 fell by 13.3%, including in Briceni rayon – 19.0%, in Donduşeni rayon – 17.1%, in Edineţ rayon – 13.4% and in the Ocniţa rayon – 15.8%.

Analyzing demographic trends in WMZ 8 some particularities have been identified. Thus in three of four WMZ 8 rayons, namely in Briceni, Donduşeni and Ocniţa one can observe a higher decrease of the urban population comparing with rural population. The only Edineţ rayon shows a slower decrease of the urban population comparing with rural population although the difference is not so big. This can be explained by rural-urban migration, emigration abroad and other negative demographic trends.
During the period of 2009-2015 the rural population decreased by 17.4% in Briceni, by 14.1% in Donduşeni, by 13.7% in Edineţ rayon and by 18.9% in Ocnita rayon, while the urban population decreased with by 16.2% in Briceni, by 18.4% in Donduşeni, by 12.7% in Edinet rayon and by 29.0% in Ocnita rayon.

In total per WMZ 8 the rural population decreased by 10.8% during the period of 2009-2015, while the urban population decreased with 20.2%.

Table 2-18: Dynamic of the present population in WMZ 8, 2009-2015, persons, %

	2009	2010	2011	2012	2013	2014	2015	2015/2009, %
Briceni rayon	76,054	75,559	75,159	74,552	74,371	70,029	69,217	91.0
Urban	14,025	13,997	14,097	13,986	13,983	11,999	11,755	83.8
Rural	62,029	61,562	61,062	60,566	60,388	58,030	57,462	92.6
Donduşeni rayon	44,679	44,361	43,934	43,610	43,171	37,856	37,021	82.9
Urban	9,544	9,510	9,510	9,476	9,437	7,101	6,832	71.6
Rural	35,135	34,851	34,424	34,134	33,734	30,755	30,189	85.9
Edineţ rayon	81,870	81,572	81,189	80,821	80,549	71,849	70,937	86.6
Urban	25,608	25,570	25,570	25,561	25,792	22,710	22,359	87.3
Rural	56,262	56,002	55,619	55,260	54,757	49,139	48,578	86.3
Ocnița rayon	55,257	54,927	54,754	54,413	54,127	47,425	46,507	84.2
Urban	19,108	19,070	19,070	19,046	18,943	14,087	13,559	71.0
Rural	36,149	35,857	35,684	35,367	35,184	33,338	32,948	91.1

	2009	2010	2011	2012	2013	2014	2015	2015/2009, %
Total WMZ 8	257,860	256,419	255,036	253,396	252,218	227,159	223,682	86.7
Urban	68,285	68,147	68,247	68,069	68,155	55,897	54,505	79.8
Rural	189,575	188,272	186,789	185,327	184,063	171,262	169,177	89.2

Source: GIZ/MLPS, calculations based on NBS 2016 data

Forecast

In order to determine the population development forecasts in WMZ 8 the average annual growth rate of population in all localities of the project area was calculated for the period 2007-2015. For the period 2015-2016 the average annual growth rate was used for extrapolation of the population trends figures, taking into account that during the short time periods the population is developing following a quasi-linear trend. The model of the Demographic Center of the National Institute for Economic Researches was used for the elaboration of the forecast on the period of 2016-2040. This model gives a general trend for urban and rural population of the Republic of Moldova for the period 2015-2035. Using the standard forecast function from Excel this figures have been extrapolated till 2040. This model was adjusted at the level of WMZ 8 with the assumption that the share of each locality in the total population will not vary significantly during the period 2015-2040.

Assuming also a stable demographic trend the forecasts for the population in WMZ 8 and selected rayons for the period 2015-2040 have been obtained. This forecast shows a general decrease of the population in WMZ 8 during the period 2015-2040.
In general per WMZ 8 is assumed a population decline by about 22% that means a decline with almost 49 thousand people, from 223.7 thousand persons in 2015 to 174.8 thousand persons in 2040.

More detailed demographic forecasts for WMZ 8 rayons are presented in **Annex 1**.

Table 2-19: The forecast of the present population in WMZ 8, 2015-2040, persons,

	2015	2020	2025	2030	2035	2040
Briceni rayon	69,217	65,618	62,240	59,074	56,349	54,082
Urban	11,755	11,144	10,570	10,032	9,570	9,185
Rural	57,462	54,475	51,669	49,041	46,779	44,897
Donduşeni rayon	37,021	35,096	33,289	31,596	30,138	28,926
Urban	6,832	6,477	6,143	5,831	5,562	5,338
Rural	30,189	28,619	27,146	25,765	24,577	23,588
Edineţ rayon	70,937	67,249	63,786	60,542	57,749	55,426
Urban	22,359	21,197	20,105	19,082	18,202	17,470
Rural	48,578	46,052	43,681	41,459	39,547	37,956
Ocniţa rayon	46,507	44,089	41,819	39,692	37,861	36,338
Urban	13,559	12,854	12,192	11,572	11,038	10,594
Rural	32,948	31,235	29,627	28,120	26,823	25,743
Total WMZ 8	223,682	212,053	201,134	190,903	182,097	174,771
Urban	54,505	51,671	49,011	46,518	44,372	42,587
Rural	169,177	160,381	152,123	144,385	137,725	132,184

Source: GIZ/MLPS, calculations based on NBS 2017 data

2.2.5 Source of income

Current situation

Regional data provided by NBS about disposable income are available only at the level of regions. Thus the disposable income per person in North Development Region North (NDR) in 2015 was of about 1839 that is lower than the average level per country of 1,957 MDL, but is higher than in Centre Development Region Centre (CDR) – 1,732 MDL and in South Development Region (SDR) – 1,705 MDL. During the period 2011-2015 disposable income per person in NDR has grown more dynamic comparing with the average level per country.

Table 2-20: Dynamics of the average monthly disposable income per person, 2011-2015, MDL. %

	2011	2012	2013	2014	2015	2015/2011, %
Republic of Moldova	1,444.7	1,508.8	1,681.4	1,767.5	1,956.6	135.4
Chisinau municipality	2,031.2	2,083.1	2,321.0	2,292.6	2,578.3	126.9
NDR	1,320.9	1,412.6	1,572.6	1,697.2	1,838.8	139.2
CDR	1,254.5	1,317.2	1,437.9	1,564.3	1,732.4	138.1
SDR	1,208.1	1,247.2	1,419.1	1,526.6	1,704.8	141.1

Source: GIZ/MLPS, calculations based on NBS 2016 data

According to the NBS data for 2015 the bulk of disposable income per person in NDR originated from salaries (31.5%), followed by remittances from abroad (22.2%) and pensions (20.5%). It is worrisome the trend of decreasing the share of paid employment in the structure of disposable income in the DRN. Thus it decreased by 8.4% during the period 2012-2015, from 34.4% to 31.5%. In the same period the share of transfers from abroad increased by almost 27%, from 17,5% to 22.2%, while the share of pensions in the total disposable income per person in NDR increased from 19.2% to 20.5% in the same period.

Table 2-21: Structure of the disposable income in the DRN, 2011-2015, %

	2011	2012	2013	2014	2015	2015/2011, %
Paid employment	34.4	31.9	29.5	30.5	31.5	91.6
Individual agricultural activity	14.9	14.1	14.0	13.7	13.3	89.3
Individual non-agricultural activity	5.1	4.5	5.7	3.8	5.2	102.0
Property income	0.1	0.0	0.1	0.0	0.1	100.0
Social benefits	22.9	23.3	23.5	23.4	23.5	102.6
including pensions	19.2	19.8	20.6	21.0	20.5	106.8
Other incomes	22.7	26.2	27.2	28.5	26.5	116.7
of which transfers from abroad	17.5	20.7	22.2	23.4	22.2	126.9

Source: GIZ/MLPS, calculations based on NBS 2016 data

There are differences in the amount of disposable income in rural and urban areas. Thus, in 2015 a resident of the village had an average disposable income by 15.3% lower than the average in the country. In the same time the average disposable income of urban dwellers was higher than the average in the country with almost 20%. There is a slight trend toward reduction of the disparity between the level of the average disposable income in urban and rural areas. Thus the level of disposable income in urban areas related to the average

income level per country is gradually decreasing, while the same indicator in rural area shows an increasing trend.

Table 2-22: Dynamics of the average monthly disposable income per person, 2011-2015, MDL. %

	2011	2012	2013	2014	2015
Total per country	1,444.7	1,508.8	1,681.4	1,767.5	1,956.6
Urban	1,792.8	1,869.0	2,046.3	2,111.1	2,350.1
% of average income	124.1	123.9	121.7	119.4	120.1
Rural	1,186.4	1,242.8	1,406.1	1,505.7	1,657.5
% of average income	82.1	82.4	83.6	85.2	84.7

Source: GIZ/MLPS, calculations based on NBS 2016 data

There are also differences between the average monthly gross earnings function to the gender. Thus on average for the period 2011-2015 the average monthly gross earnings received by women in the North region was almost 9% lower than the salary received by men in the same region. To mention that differences between the average monthly gross earnings of women and men in WMZ 8 rayons are less obvious comparing with the average level per country, excepting Donduşeni rayon where this indicator lower than the country's average level.

Table 2-23: The average monthly gross earnings by gender, 2011-2015, MDL, %

	2011		2012		2013		2014		2015		AVG 2011-2015		
	W	M	W	M	W	M	W	M	W	M	W	M	W vs. M, %
Total RM	2,857	3,253	3,168	3,638	3,460	3,914	3,832	4,375	4,235	4,881	3,510	4,012	87.5
CDR	2,417	2,581	2,648	2,928	2,840	3,221	3,191	3,513	3,580	3,895	2,935	3,228	90.9
SDR	2,255	2,418	2,511	2,657	2,727	2,960	3,028	3,378	3,396	3,691	2,783	3,021	92.1
NDR	2,531	2,701	2,791	3,046	3,040	3,306	3,371	3,708	3,695	4,094	3,086	3,371	91.5
Briceni rayon	2,018	1,953	2,380	2,628	2,636	2,831	2,975	3,309	3,121	3,509	2,626	2,846	92.3
Donduşeni rayon	2,278	2,630	2,549	2,950	2,752	3,274	3,029	3,414	3,305	3,753	2,783	3,204	86.8
Edineţ rayon	2,321	2,340	2,528	2,689	2,681	3,059	3,003	3,418	3,331	3,615	2,773	3,024	91.7
Ocniţa rayon	2,195	2,674	2,430	2,776	2,772	2,992	3,056	3,266	3,326	3,610	2,756	3,063.6	90.0

Source: GIZ/MLPS, calculations based on NBS 2016 data

Forecast

The analysis of the dynamics of the average monthly disposable income per person in different regions of the country demonstrated that it fits very well the linear trend. Therefore a linear regression of the standard Excel forecast function was used to establish the forecast of the average monthly disposable income per person in different regions of the country.

This forecast shows that the level of the average monthly disposable income per person will increase during the period 2015-2040 more about 2.6 times in NDR, while CDR and SDR it will increase about 2.4 times and will reach in 2040 the level of 4,746 MDL in NDR, 4,211 MDL in CDR and 4,101 MDL in SDR.

Table 2-24: Forecast for the development of the average monthly disposable income per, 2015-2040, MDL

	2015	2020	2025	2030	2035	2040
CDR	1,732	2,173	2,683	3,192	3,702	4,211
NDR	1,839	2,401	2,988	3,585	4,181	4,746
SDR	1,705	2,119	2,615	3,110	3,605	4,101

Source: GIZ/MLPS, calculations based on NBS 2016 data

2.2.6 Unemployment

The number of officially registered unemployed in NDR is relatively higher comparing with other regions of the country and reached the level 11,596 persons in 2015 or about 43% of the total number of the registered unemployed per country. The number of unemployed persons in WMZ 8 rayons was of 3,747 persons in 2015, of which in Briceni - 562 persons, in Donduşeni – 1,151 persons, in Edineţ - 736 and Ocniţa – 1,298 persons.

One can mention a relatively stable level of the number of unemployed persons in the WMZ 8 rayons comparing with a more dynamic decrease of this indicator per country. Moreover in the Ocniţa rayon the number of unemployed persons increased in 2015 with 1% comparing with the year 2011.

The overall decreasing trend of the number of unemployed persons in general per country, but also in regions and rayons can be explained either by migration of the population abroad, but also by changes in the methodology of calculation applied by the National Bureau of Statistics. Some particularities are related to the decrease of the number of unemployed persons in the period 2011-2013, followed by an increase of the number of unemployed persons in the period 2014-2015.

Table 2-25 Number of unemployed persons, 2011-2015

	2011	2012	2013	2014	2015	2015/2011, %
Total per country	38,752	26,297	20,873	20,726	26,908	69.4
Chişinău municipality	4,369	3,157	3,049	1,645	1,913	43.8
Region Center	12,488	9,556	7,191	6,856	8,286	66.4
Region South	4,735	3,348	3,110	3,338	3,979	84.0
Region North	15,431	9,097	6,819	8,083	11,596	75.1
WMZ 8	4,560	2,971	2,279	2,729	3,747	82.2
Briceni rayon	740	428	345	421	562	75.9
Donduşeni rayon	1,512	871	651	908	1151	76.1
Edineţ rayon	1,023	919	820	621	736	71.9
Ocniţa rayon	1,285	753	463	779	1,298	101.0

Source: GIZ/MLPS, calculations based on NBS 2016 data

The relative figures of the unemployment rate confirm the same trend of decrease during the period 2011-2014, followed by an increase in 2015. Additionally this figures show that in 2015 the unemployment rate in the NDR (4.5%) was higher comparing with CDR (4.0%) and SDR (3.4%).

Table 2-26 Unemployment, 2011-2015, %

	2011	2012	2013	2014	2015	2015/2011, %
Total per country	6.7	5.6	5.1	3.9	4.9	73.1
Chişinău municipality	9.3	8.2	6.3	6.0	7.0	75.3
NDR	5.2	4.6	3.9	2.4	4.5	86.5
CDR	5.7	4.5	4.9	3.2	4.0	70.2
SDR	6.2	4.1	5.6	3.6	3.4	54.8

Source: GIZ/MLPS, calculations based on NBS 2016 data

It is important to mention that unemployment is more common in rural than in urban areas.

3 General legislative framework

3.1 Current legislation

The main existing legislation on municipal waste management in the Republic of Moldova are the Law on waste and the Governmental Decision approving the Waste Management Strategy.

The new Law on waste

The new Law on waste was approved by Governmental Decision no. 775 of 28.10.2015 and published in December 2016 (Law 209/2016). The law will be in force in December 2017.

The new Law on waste transposes the Waste Directive 2008/98/CE of the European Parliament and of the Council of 19 November 2008 repealing certain directives, but it also includes provisions of the directives on special waste flows.

Article 14 on reusing and recycling waste provides the following state policy objectives in order to meet the objectives of the law and to reach a high level of efficiency regarding the use of resources:

- introducing separate collection systems for paper, metals, plastics, and glass by 2018;
- by 2020, preparing for reusing and recycling waste, such as paper, metals, plastics, and glass resulting from household use at least, or from other sources if these waste flows are similar to domestic waste flows; this will have to reach a minimum global level of 30% of the total weight;
- by 2020, preparing for reuse and other recovery operations, including backfilling operations that use waste to replace other substances, non-hazardous waste resulting from construction and demolition works, except for natural geological materials; this will be increased to a minimum level of 55% of the total weight.

The Law includes provisions on the extended producer responsibility (EPR). The following flows will be primarily subject to the EPR principle: batteries and accumulators, electric and electronic equipment, vehicles, oils, packaging. The implementation mechanism of the EPR scheme for each flow will be determined by means of specific normative acts approved by the Government.

The Governmental Decision no. 248 of 10.04.2013 approving the Waste Management Strategy in the Republic of Moldova for 2013-2027

The National Waste Management Strategy (NWMS) is the strategic document that is used to define investment projects in the waste management field.

The Governmental Decision provides the fact that the Ministry of Environment will cooperate with international bodies and possible financers in order to attract the volume of investment

necessary to enable a sustainable development of the waste management sector. Also, it will present to the Government every year, by April 10, the report on achieving the provisions of the National Strategy. The other ministries and central administrative authorities shall take all the necessary measures in order to carry out completely and within the agreed timing the actions envisaged for the implementation of NWMS. They must inform annually, by February 10, the Ministry of Environment with regard to carrying out the measures included in NWMS. It is also mentioned the fact that the beneficiaries of investment projects in the waste management field must first coordinate with the Ministry of Environment with regard to the concepts of the planned projects, and it is recommended that local public administration authorities create waste management associations between rayons in order to attract the necessary investments in this sector.

The National Strategy refers to all types of waste.

The National Strategy defines both general objectives as well as specific ones. The general objectives are the following:

- Developing the integrated municipal waste management systems by harmonizing the legislative, institutional and normative framework with EU standards, based on a regional approach (geographical position, economic development, the existence of access roads, soil and hydro-geological conditions, the number of inhabitants, etc.) and dividing the country into 8 waste management zones;
- Developing the regional infrastructure of municipal waste landfills and transfer stations;
- Developing the collection and treatment systems of specific waste flows (packaging waste, WEEE, tyres, batteries, etc.) by promoting and implementing the ”Extended Producer Responsibility principle” and for hazardous waste (medical waste, used oils, etc.) by setting up one collection point for each region.

Taking into consideration the three development regions, the NWMS defines 8 zones for the integrated management of municipal waste, namely:

- in South Development Region – three waste management zones (Zone 1 South, Zone 2 South Centre, Zone 3 South East);
- in Centre Development Region – three waste management zones (Zone 4 Chisinau, Zone 5 West Centre, Zone 6 East Centre);
- in North Development Region – two waste management zones (Zone 7 Balti, Zone 8 North).

Figure 3-1: Waste management zones according to the National Waste Management Strategy

Source: "The Waste Management Strategy in the Republic of Moldova for 2013-2027"

The waste management zone envisaged in this Feasibility Study is Zone 8 North.

NWMS also defines specific objectives for each category of waste, in additional to the general objectives. With regard to municipal waste, the following specific objectives have been defined:

- promoting and implementing separate collection systems in all localities, both for the population and for industry, together with sorting, composting and recycling stations;
- improving the waste transport system and developing transfer stations (4-7 stations for each rayon);
- developing the capacities for disposal of municipal waste (building 7 regional landfills for municipal waste and 2 MBT stations);
- improving institutional governing in the field of municipal waste management by setting up associations of the local public authorities at a regional level (8 associations).

Besides the specific objectives concerning municipal waste, NWMS also presents specific objectives concerning special waste flows. For packaging waste, the specific objectives are the following:

- increasing the rate of recovery of packaging waste by 20% until 2027;
- developing the material and energetic recovery schemes of packaging waste that cannot be recycled.

Annex 1 to NWMS presents the Action Plan, defining for each general and specific objective, the actions to be taken, the deadlines for completion, the institutions in charge, the estimated costs, the financing source, as well as the monitoring indicators.

The main actions identified with regard to the general objective ”Developing the regional infrastructure of solid household waste landfills”, and with regard to the specific objective ”Providing waste collection and transport systems for the largest number of waste generators” are the following:

- Expanding the activity of waste collection and disposal companies from urban localities to rural ones – timetable 2013 - 2015, institutions in charge: the Ministry of Environment and local public authorities;

- Setting up waste collection systems in urban/rural areas by procuring containers and setting up transfer stations, introducing and expanding separate collection at the point of generation - timetable 2013 - 2016, institutions in charge: the Ministry of Environment and local public authorities;

- Setting up optimal schemes by having specialised transport at the level of each region – timetable 2013 - 2016, institutions in charge: the Ministry of Environment, local public authorities, and the Ministry of Transport and Roads Infrastructure;

- Setting up a collection and transport system for hazardous waste – timetable 2015 - 2017, institutions in charge: the Ministry of Environment, local public authorities, and the Ministry of Transport and Roads Infrastructure;

- Reducing the number of existing dumpsites by setting up 4-6 transitional disposal sites at the regional level – timetable 2014 - 2016, institutions in charge: the Ministry of Environment and local public authorities;

- Drawing up the plans for closure of dumpsites non-compliant with EU standards – timetable 2014 - 2017, institutions in charge: the Ministry of Environment and local public authorities;

- Drawing up feasibility studies for the construction of 2-3 landfills for solid household waste in the Development Region South – timetable 2013 - 2014, institutions in charge: the Ministry of Environment; regional development agencies;

- Building regional landfills and transfer stations for solid household waste - timetable 2014 - 2017, institutions in charge: the Ministry of Environment; the Ministry of Regional Development and Constructions.

3.2 New national legal regulations

The Association Agreement between the Republic of Moldova and the European Union was ratified by Law no. 112 of 02.07.2014. Chapter 16 – The Environment, the sub-chapter on the management of waste and resources includes three directives that must be transposed into the national legislation (Directive 2008/98/EC on waste, Directive 1999/31/EC on the landfill of waste as amended by Regulation (EC) 1882/2003, Directive 2006/21/EC on the management of waste from extractive industries and amending Directive 2004/35/EC)**.**

For the first two directives, including provisions on municipal waste, the following provisions shall be applicable:

- Directive 2008/98/EC on waste:
  - adoption of national legislation and designation of competent authority/ies – timetable within 2 years of the entry into force of this agreement
  - preparation of waste management plans in line with the five-step waste hierarchy and of waste prevention programmes (Chapter V) - timetable within 4 years of the entry into force of this agreement;
  - *establishment of full cost recovery mechanism in accordance with the polluter pays principle and extended producer responsibility principle (art. 14) - timetable within 4 years of the entry into force of this agreement;*
  - establishment of a permitting system for establishments/undertakings carrying out disposal or recovery operations, with specific obligations for the management of hazardous wastes (Chapter IV) - timetable within 5 years of the entry into force of this agreement;
  - establishment of a register of waste collection and transport establishments and undertakings (Chapter IV) – timetable within 5 years of the entry into force of this agreement

- Directive 1999/31/EC on the landfill of waste as amended by Regulation (EC) 1882/2003**:**
  - adoption of national legislation and designation of competent authority/ies – timetable within 3 years of the entry into force of this agreement
  - classification of landfill sites (art. 4) – timetable within 4 years of the entry into force of this agreement;
  - preparation of a national strategy reducing the amount of biodegradable municipal waste going to landfill (art. 5) - timetable within 5 years of the entry into force of this agreement;
  - establishment of an application and permit system and of waste acceptance procedures (art. 5-7, 11, 12 and 14) - timetable within 4 years of the entry into force of this agreement

- establishment of control and monitoring procedures in the operation phase of landfills and of closure and after-care procedures for landfills to be disaffected (art. 12 and 13) - timetable within 7 years of the entry into force of this agreement;
- establishment of conditioning plans for existing landfill sites (art. 14) - timetable within 7 years of the entry into force of this agreement;
- establishment of a costing mechanism (art. 10) - timetable within 5 years of the entry into force of this agreement;
- ensuring the relevant waste is subject to treatment before landfilling (art. 6) - timetable within 7 years of the entry into force of this agreement.

The Governmental decision no. 808 of 7 October 2014 "*approving the National Action Plan for the implementation of the Association Agreement between the Republic of Moldova and the European Union between 2014-2016*" further amended and completed includes the action plan on drawing up and approving the regulating documents, according to the provisions of the Association Agreement. Most of these measures must be completed by 2016.
Taking into consideration the provisions of NWMS, as well as those of the Association Agreement between the Republic of Moldova and the European Union, and of the National Action Plan, the Ministry of Environment has already elaborated a series of draft regulating documents both for transposing the Waste Framework Directive, and with regard to the main waste management operations, and special waste flows.

Recently, three draft Governmental Decisions have been open for public consultations: the approval of the Regulation concerning packaging and packaging waste, the approval of the Regulation on the landfill of waste, and the approval of the Regulation on batteries and accumulators and waste batteries and accumulators.
The first two regulations impact the design of the integrated waste management systems.

The draft Governmental Decision regarding the approval of the Regulation on packaging and packaging waste[4] was open for public consultations from 14.09.2016 to 14.10.2016.
The draft regulation partly transposes into the national legislation the provisions of Directive 94/62/EC on packaging and packaging waste further amended and completed.
The draft regulation provides in art. 14 that local public authorities or, according to the case, the inter-community development associations are responsible, through the sanitation operator, for the separate collection, transport to sorting stations, sorting household waste and similar waste, including packaging waste and sending it for recovery. The draft introduces the EPR scheme for packaging waste. Thus, art. 19 states that collective systems will have to ensure the takeover of packaging waste that they are responsible for from sorting stations, and to pay to local public authorities the difference between collection, transport, temporary storage, and sorting costs and the revenues obtained from selling materials and to ensure recovery thereof.

The draft regulation also provides global recycling and recovery objectives, as well as recycling objectives for each type of material for different stages in the period 2018-2025.

[4] http://particip.gov.md/proiectview.php?l=ro&idd=3497, accessed in November 2016

The draft Governmental Decision regarding the approval of the Regulation on the landfill of waste[5] was open for public consultations from 27.10.2016 to 16.11.2016.
The regulation transposes into the national legislation the provisions of Directive 1999/31/EC on the landfill of waste as amended by Regulation (EC) 1882/2003.
The main provisions of the draft regulation that impact municipal waste landfills are the following:

- The landfill of waste is allowed only if the waste has been previously subjected to technically feasible treatment operations in order to comply with the provisions set forth in the Regulation;
- When building regional landfills, local public administration authorities shall take into account the provisions of the Waste Management Strategy in the Republic of Moldova for 2013-2027, the provisions of the Action Plan on the implementation of the Waste Management Strategy, the provisions of the Law on the principles of urbanism and country planning, as well as the Waste Management Regional Programmes;
- Municipal waste landfills must be regional landfills, serving at least 200-300 thousand inhabitants, according to the Waste Management Strategy in the Republic of Moldova for 2013-2027;
- Rayonal councils jointly with local councils of the local public administration, in accordance with the law on local public administration, make decisions on creating the associations as well as on the collaboration with companies and NGOs in order to implement the proper management of the activities concerning the landfill of municipal waste;
- If landfills serve two or more rayons, the operation programme as well as the costs of the landfill operations shall be jointly determined with all the authorities of the local public administration that are involved.

Furthermore, the draft regulation includes provisions on:

- Specific authorization requirements;
- Guidelines for accepting waste in landfills;
- Guidelines for control and monitoring during the operation of the landfills;
- Guidelines for closing and after-care procedures;
- General location and design requirements for a landfill;
- Analysing accepted locations and the criteria used in this analysis;
- General requirements for designing and building a landfill (the operation period must be at least 20 years);
- General requirements for bottom sealing;
- Recommendations on surface sealing;
- General requirements for the control and protection of environmental factors;
- Gas control;
- Ensuring stability;
- Security and safety systems;
- Fighting other drawbacks and mitigating risks;
- Fitting in the landscape;

[5] http://particip.gov.md/proiectview.php?l=ro&idd=3606, accessed in November 2016

- General aspects concerning the way in which criteria and guidelines for accepting waste in the landfill are applied;
- Guidelines for landfill control and monitoring.

4 Current situation on waste generation and forecast

4.1 Current situation on waste generation

The scope of the feasibility study is the management of municipal waste in WMZ 8.

Law no. 209/2016 on waste (Law no. 209/2016) defines, in art. 2, municipal waste as household waste and similar waste resulting from commercial, industrial, and administrative activities mentioned at point 20 in the List of Waste, approved by the Government.

We should mention the fact that the List of waste has not been approved by the Government yet, but the reference in Law no. 209/2016 to municipal waste at point 20 indicates that the list that is going to be approved is the European List of waste approved by the Commission Decision 2000/532/EC.

Thus, according to the European List of waste, the main categories of municipal waste are the following:

- Household waste – waste generated by households, mixedly or separately collected;
- Similar waste – waste in nature and composition comparable to household waste, excluding production waste and waste from agriculture and forestry, mixedly or separately collected;
- Garden and park waste - green waste;
- Street waste – street cleaning residues;
- Bulky waste;
- Market waste.

Municipal waste also includes the following special flows: hazardous household waste, waste electrical and electronic equipment, waste batteries and accumulators. Section 7 presents aspects regarding the generation and management of these special flows.

4.1.1 Amount of municipal waste

At present, as section 5 shows, in WMZ 8, the coverage of the sanitation service is approximately 68% in urban areas, and 2% in rural areas. Besides, the whole amount of collected municipal waste is disposed of in dumpsites, which are not equipped with weighbridge.

Therefore, the currently generated waste amount can only be estimated based on indicators.

The generation indicators of household waste were estimated in the Report on *"Analysis of household waste in urban and rural areas"*, July 2014, elaborated by GIZ/MLPS, as follows:

- Rural areas – 0.4 kg/inhabitant x day;
- Urban areas, towns with a population of up to 15,000 inhabitants – 0.5 kg/inhabitant x day;

- Urban areas, towns with a population between 15,000 and 40,000 inhabitants – 0.7 kg/inhabitant x day.

In WMZ 8, the population in the towns is below 15,000 inhabitants.

The following assumptions will be used in order to estimate the amount of all the other categories of municipal waste:

- Similar waste – 25% of the total household waste in urban areas, and 10 % in rural areas;
- Garden and park waste – 0.05 kg/capita/day in urban areas;
- Bulky waste - 20% of the total household and similar waste in urban areas, and 10 % in rural areas;
- Street and market waste – total of 8% of household waste in urban areas.

These assumptions are based on:

- the assumptions used in the elaboration of other feasibility studies in the Republic of Moldova (Feasibility Study for WMZ 1, Feasibility Study for Soldanesti zone);
- the European statistic data (EUROSTAT);
- the Consultant's experience in other states similar to the Republic of Moldova.

Based on these indicators and on the number of inhabitants in each rayon (see section 2.2.4) the amount of municipal waste generated in WMZ 8 in 2016 has been estimated.

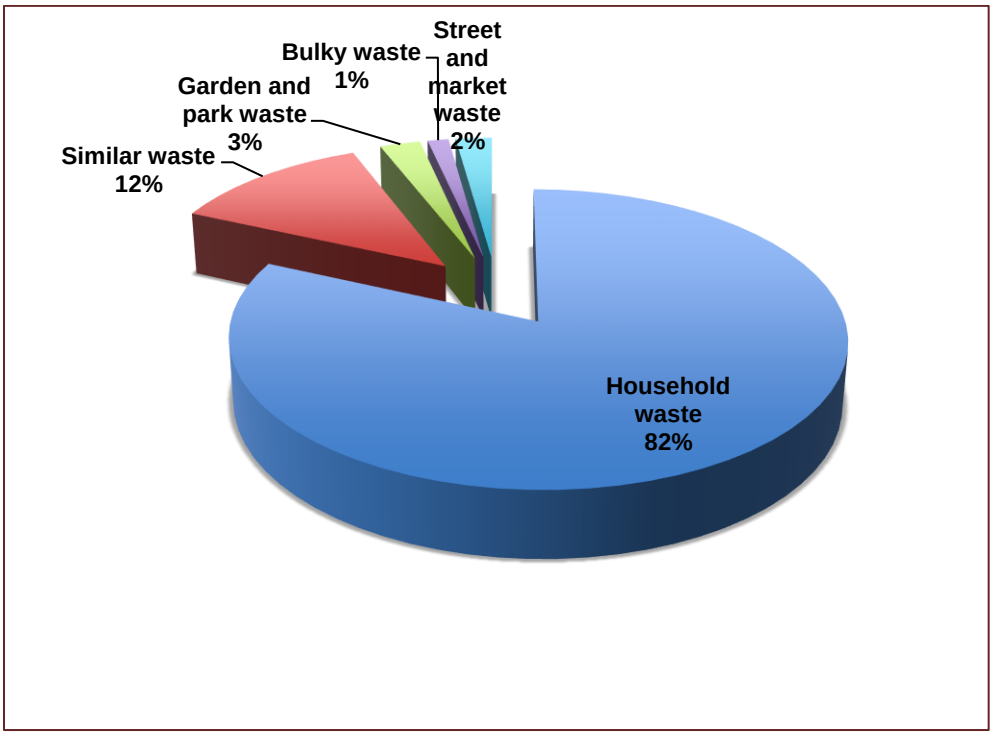
Table 4-1: Estimated amount of municipal waste generated in WMZ 8, in 2016

Type of municipal waste	Generated amount (tonnes/year)
Municipal waste from urban area, out of which:	**14,315**
Household waste	9,839
Similar waste	2,460
Garden and park waste	984
Bulky waste	256
Street and market waste	**777**
Municipal waste from rural area, out of which:	**27,142**
Household waste	24,430
Similar waste	2,443
Bulky waste	269
Total municipal waste generated in WMZ 8	**41,457**

Source: GIZ/MLPS

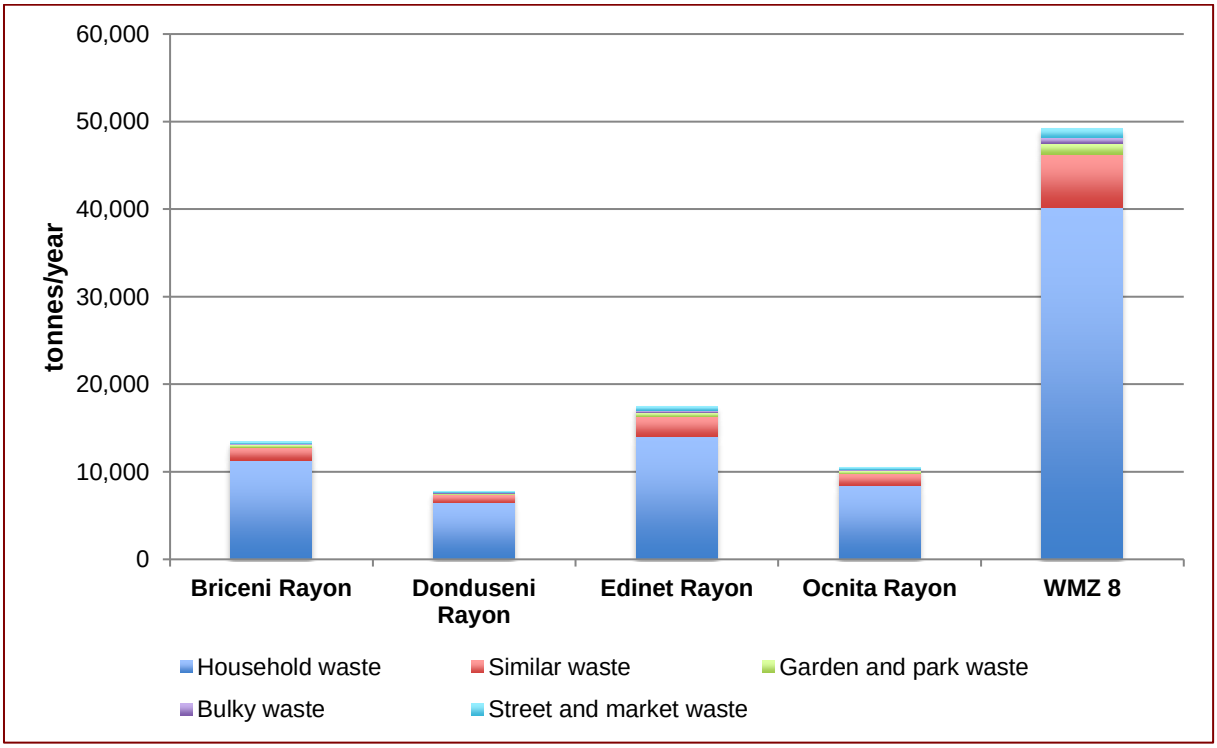
The graphs below show the structure of municipal waste at zone level as well as per rayon.

Figure 4-1: Structure of municipal waste, WMZ 8



Source: GIZ/MLPS

Figure 4-2: Structure of municipal waste per rayons, WMZ 8



Source: GIZ/MLPS

In WMZ 8, the amount of municipal waste estimated to be generated in 2016 was about 41,000 tonnes, of which about 35% in urban areas, and about 65% in rural areas. The larger amount of waste generated in rural areas as compared to urban areas is due to the large number of inhabitants in rural areas in this zone (about 76%).

Considering the ratio between the amount of municipal waste and the population in this zone, the generation indicator of municipal waste is about 187 kg/inhabitant x year. This indicator is less than half of the EU-28 average for 2015 (476 kg/inhabitant x year), but only about 76% of the generation indicator for Romania (247 kg/inhabitant x year)[6].

4.1.2 Municipal waste composition

Analyses on the composition of household waste and similar waste were carried out within the GIZ/MLPS project during the elaboration of the Feasibility Study for Soldanesti zone, as well as during the elaboration of the Feasibility Study for WMZ 1. Based on the results of these analyses, as well as on the Consultant's experience from other states similar to the Republic of Moldova, the composition of household waste, as well as of similar waste has been estimated separately for urban and rural areas.

Table 4-2: Composition of household and similar waste in urban area

Type of waste	Composition of household waste in urban area (%)	Composition of similar waste in urban area (%)
Plastic	10.00	20.00
Paper & cardboard	5.00	40.00
Glass	4.00	10.00
Metal	3.00	5.00
Organic	27.50	3.50
Green waste	27.50	3.50
Wood	0.00	0.00
Textile	3.00	8.00
Inert	5.00	3.00
Other	14.50	6.50
Hazardous waste	0.50	0.50

Source: GIZ/MLPS

Table 4-3: Composition of household and similar waste in rural area

Type of waste	Composition of household waste in rural area (%)	Composition of similar waste in rural area (%)
Plastic	5.00	10.00
Paper & cardboard	2.00	40.00
Glass	4.00	10.00
Metal	1.00	5.00
Organic	17.50	7.50
Green waste	17.50	7.50
Wood	0.00	0.00
Textile	3.00	8.00

[6] http://ec.europa.eu/eurostat/web/waste/transboundary-waste-shipments/key-waste-streams/municipal-waste, accessed March 2017

Type of waste	Composition of household waste in rural area (%)	Composition of similar waste in rural area (%)
Inert	35.00	5.00
Other	14.50	6.50
Hazardous waste	0.50	0.50

Source: GIZ/MLPS

Household waste differs considerably from similar waste, both in urban areas, as well as in rural areas. If bio-waste has the largest amount within household waste, recyclable waste stands for the largest amount within similar waste.

Thus, the share of bio-waste within household waste has been estimated at 50% in urban areas and 35% in rural areas. In similar waste, the share of bio-waste has been estimated to be only 7% in urban areas and 15% in rural areas.

For household waste, the share of recyclable waste (plastic, paper, cardboard, glass, metal, and textile waste) has been estimated at 25% in urban areas and 10% in rural areas. For similar waste, the share of recyclable waste is significantly larger, namely about 80% in urban areas and about 70% in rural areas.

4.2 Municipal waste forecast

Since the current situation has been analysed based on 2016 data, the forecast has been calculated for 2017-2040.

4.2.1 Forecast of municipal waste generation

The forecast of municipal waste generation has been calculated based on the population forecast (section 2.2.4) and on the forecast of generation indicators for municipal waste.

With regard to the forecast of generation indicators, it is assumed that it follows the GDP trend, namely a 0.2% increase for each percentage of the GDP rise. As the GDP forecast shows an annual increase of 2% (see section 2.2.2), it results an annual increase rate of the generation indicators for municipal waste of 0.4%.

As the Republic of Moldova has no waste generation prevention programme yet, the impact of prevention measures has not been taken into consideration when the generation forecast of municipal waste was calculated. If the National Waste Generation Prevention Programme is elaborated over the next few years, the impact of the measures proposed could occur starting with 2021. The year 2021 is the year assumed for the starting operation of integrated waste management system. Thus, the capacities of the collection and transport system, and of the facilities are calculated based on quantities estimated for this year.

Based on these assumptions, the generation forecast of municipal waste has been calculated for each LPA in WMZ 8, as well as for the total amount generated in each rayon and at zone level (**Annex 2**). The table below shows the amounts of municipal waste estimated to be generated per rayon and in the zone for the next reference years:

- 2017 – the first year when the forecast is calculated;
- 2021 – the year estimated for an operational integrated waste management system;
- 2025, 2030, 2035, 2040.

Table 4-4: Forecast of municipal waste generation in the reference years

Rayons/WMZ 8	Amount of municipal waste (tonnes/year)					
	2017	2021	2025	2030	2035	2040
Briceni Rayon	12,223	11,907	11,597	11,229	10,927	10,699
Donduseni Rayon	6,593	6,423	6,255	6,057	5,894	5,771
Edinet Rayon	13,574	13,223	12,878	12,470	12,134	11,881
Ocnita Rayon	8,787	8,560	8,337	8,073	7,856	7,692
Total WMZ 8, out of which:	41,177	40,113	39,068	37,829	36,811	36,042
Urban area	14,219	13,851	13,490	13,062	12,711	12,445
Rural area	26,959	26,262	25,578	24,766	24,100	23,597

Source: GIZ/MLPS

The total amount of municipal waste estimated to be generated at the end of the forecast period, 2040, is about 13% less than the amount estimated for 2017. The amount of generated waste will decrease during the planning period, both in urban and rural area and the main reason is the decrease of population.

4.2.2 Forecast of municipal waste composition

The forecast regarding the composition of municipal waste is different for household and similar waste. For household waste, the composition is correlated with the rising standards of living, whereas this differs only slightly for similar waste.

Taking into consideration the fact that annual GDP growth has been estimated for the forecast period, an increase in the amount of recyclable waste out of household waste has been estimated, as well as an increase in the amount of organic waste, mainly food waste.

With regard to similar waste, an increase in the amount of recyclable waste has been estimated for the following years, and then it is estimated to remain stable.

The tables below show the estimates regarding the composition of both household waste and similar waste in urban and rural areas.

Table 4-5: Forecast of household waste composition in urban area

Type of waste	Share (%)			
	2017	2019	2023	Starting 2028
Plastic	10.00	11.00	12.00	13.00
Paper & cardboard	5.00	6.00	7.00	8.00
Glass	4.00	5.00	6.00	6.00
Metal	3.00	4.00	5.00	6.00
Organic	27.50	29.00	29.00	29.00
Green waste	27.50	27.50	27.50	27.50
Textile	3.00	3.00	3.00	3.00
Inert	5.00	5.00	5.00	5.00
Other	14.50	9.00	5.00	2.00

Type of waste	Share (%)			
	2017	2019	2023	Starting 2028
Hazardous waste	0.50	0.50	0.50	0.50

Source: GIZ/MLPS

Table 4-6: Forecast of household waste composition in rural area

Type of waste	Share (%)			
	2017	2019	2023	Starting 2028
Plastic	5.00	6.00	7.00	8.00
Paper & cardboard	2.00	3.00	4.00	5.00
Glass	4.00	5.00	6.00	6.00
Metal	1.00	2.00	3.00	4.00
Organic	17.50	19.00	18.00	18.00
Green waste	17.50	17.50	17.50	17.50
Textile	3.00	3.00	3.00	3.00
Inert	35.00	35.00	35.00	35.00
Other	14.50	9.00	6.00	3.00
Hazardous waste	0,50	0,50	0,50	0,50

Source: GIZ/MLPS

Table 4-7: Forecast of similar waste composition in urban area

	Share (%)	
Type of waste	2017	Starting 2019
Plastic	20.00	21.00
Paper & cardboard	40.00	42.00
Glass	10.00	11.00
Metal	5.00	6.00
Organic	3.50	4.00
Green waste	3.50	3.50
Textile	8.00	8.00
Inert	3.00	3.00
Other	6.50	1.00
Hazardous waste	0.50	0.50

Source: GIZ/MLPS

Table 4-8: Forecast of similar waste composition in rural area

	Share (%)	
Type of waste	2017	Starting 2019
Plastic	10.00	11.00
Paper & cardboard	40.00	42.00
Glass	10.00	11.00
Metal	5.00	6.00
Organic	7.50	6.00
Green waste	7.50	7.50
Textile	8.00	8.00
Inert	5.00	5.00
Other	6.50	3.00
Hazardous waste	0.50	0.50

Source: GIZ/MLPS

5 Current situation on waste management

5.1 Data collection methodology

The assessment of the current situation regarding the amounts of generated waste and the way waste is managed in WMZ 8 has been carried out based on the information provided by the public local authorities and the existing sanitation operators.

The data and information collection process has been carried out in many stages:

- April – May 2014:
- Questionnaires were developed; they were sent to be filled out by the public local authorities where there is a sanitation service, as well as to the existing sanitation operators. The representatives of the North Regional Development Agency have provided support both in terms of sending the questionnaires to the LPAs and Operators and collection of the answers;
- Meetings with the representatives of the LPAs and sanitation operators took place during which the questions of the questionnaires were clarified and additional information was collected;
- November 2016 – January 2017:
- The first questionnaires sent in 2014 have been revised and sent to LPAs and the sanitation operators to be filled in. These questionnaires aimed at collecting current data on municipal waste management in this zone. The North Regional Development Agency provided support in sending the questionnaires, just like they did the first time.
- Meetings with representatives of LPAs and sanitation operators.

The following data and information were requested through the questionnaires:

- From the public local authorities:
  - Number of population in each locality allocated to the public local authority;
  - Population per locative structure;
  - Data regarding the locative structure;
  - Information regarding the sanitation service;
  - Municipal waste collection method and frequency;
  - Endowment with collection vessels for mixed and separately collected waste;
  - Information regarding the collection and transport vehicles, including type, capacity, year of fabrication; average fuel consumption;
  - Information regarding the coverage rate with sanitation services;
  - Information regarding waste treatment and disposal;
  - Information regarding the payment mechanism for the sanitation service;

- Information regarding the on-going projects in the field of waste management;

- From the sanitation operators:
  - Data regarding the operator – legal status, number of employees, average age and tenure of the employees, etc.;
  - The served public local authorities (service area);
  - Municipal waste collection method and frequency;
  - Endowment with collection vessels for mixed and separately collected waste;
  - Information regarding the collection and transport vehicles, including type, capacity, year of fabrication; average fuel consumption;
  - Estimated municipal solid waste generation per sources;
  - Information regarding waste treatment and disposal;
  - Information regarding the payment for the sanitation service;
  - Financial information regarding the activity of the operator.

All the data and information collected on the current management of municipal waste in WMZ 8 has been included in a database in **Annex 3**. The main conclusions of the current municipal waste management system are presented below.

5.2 Sanitation operators

According to the data provided by LPAs and the sanitation operators, in January 2017, there were 13 sanitation operators in WMZ 8. All the operators are public operators, municipal enterprises. Of these 13 operators, 12 only serve the LPAs that set them up, and only one of them also serves another neighbouring LPA.

Table 5-1: Sanitation operators in WMZ 8, January 2017

Rayon	Sanitation operator	LPAs served	Activities performed
Briceni	Î.M.* Gospodăria Comunal-Locativă Briceni	Briceni	Collection and transport of household and similar waste, dumpsite operation
Briceni	Î.M. Comprod-Lipcani	Lipcani	Collection and transport of household and similar waste, dumpsite operation
Briceni	Î.M. Cricom-Service	Criva	Collection and transport of household and similar waste
Briceni	Î.M. Prestservicii-Nord	Larga	Collection and transport of household and similar waste, dumpsite operation
Briceni	Î.M. Medveja Service	Merdveja	Collection and transport of household and similar waste, dumpsite operation
Donduseni	Î.M. "Apa-Canal" Donduseni	Donduseni	Collection and transport of household and similar waste, dumpsite operation
Edinet	Î.M. DPGL - Edinet	Edinet	Collection and transport of household and similar waste,

Rayon	Sanitation operator	LPAs served	Activities performed
			dumpsite operation, sewerage
Edinet	Î.M. GCL Cupcini	Cupcini	Collection and transport of household and similar waste, dumpsite operation
Edinet	Î.M. Servicii Ruseni	Ruseni	Collection and transport of household and similar waste, dumpsite operation
Edinet	Î.M. Alexeevca	Alexeevca	Collection and transport of household and similar waste, dumpsite operation
Ocnita	Î.M. Apa Canal Ocnita	Ocnita	Collection and transport of household and similar waste, dumpsite operation
Ocnita	Î.M. GCL Otaci	Otaci, Calarasova	Collection and transport of household and similar waste, dumpsite operation
Ocnita	Î.M. GCL Frunza	Frunza	Collection and transport of household and similar waste, dumpsite operation

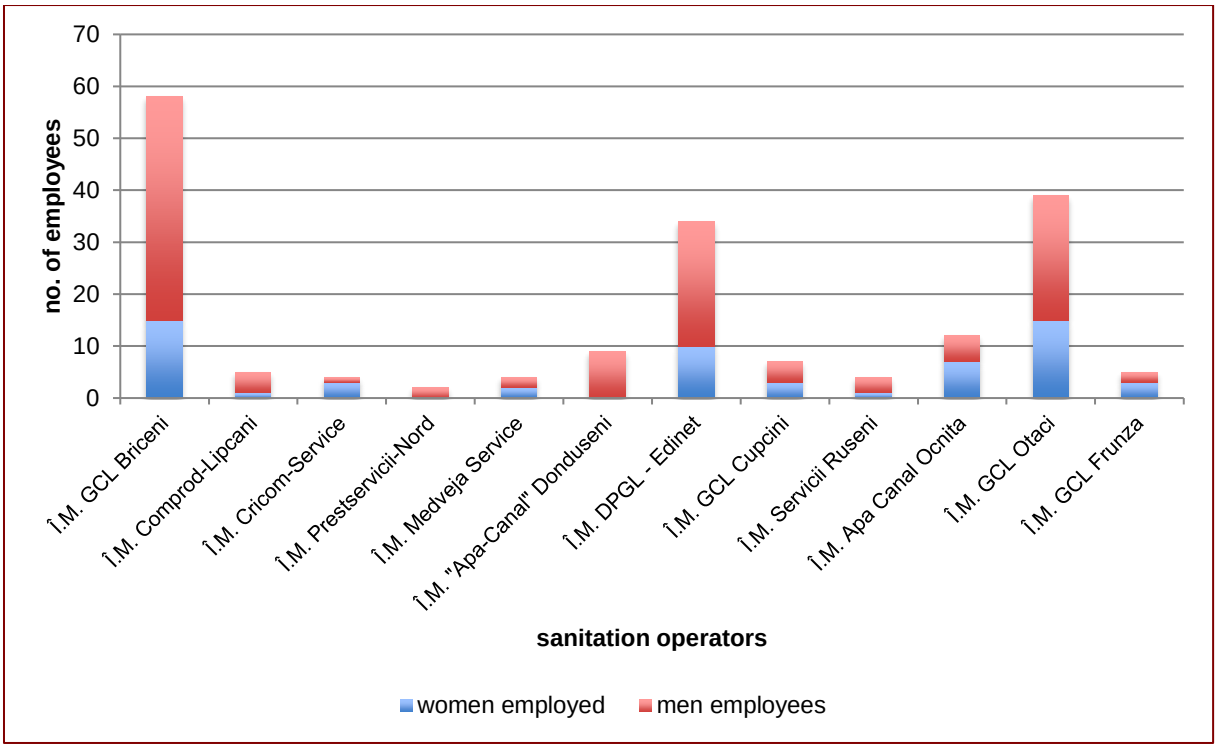
Source: GIZ/MLPS, based on the data provided by LPAs and the sanitation operators
** Municipal Enterprise*

Sanitation operators in urban areas employ between 5 and 58 people. However, municipal enterprises in rural areas have extremely few employees (1-3).

The graph below shows the number of employees of each operator in household and similar waste management.

Except for Î.M. “Apa-Canal” Donduseni, it can be noticed that the employees working for all the other operators are both women and men.

Figure 5-1: Number of employees of the sanitation operators, WMZ 8, January 2017



Source: GIZ/MLPS, based on the data provided by LPAs and by the sanitation operators

5.3 Collection and transport of municipal waste

As it can be noticed in Table 6-1, the ten current sanitation operators do not serve all LPAs in this zone. Besides, based on the data reported by the operators, not all the inhabitants are served in the localities where these operate.

The table below shows the coverage rate of the sanitation service, both at rayon level, and at zone level. A map of the zone as well as the LPAs receiving sanitation services are shown in Figure 5-2.

In WMZ 8, there are sanitation operators in all the towns. The coverage rate of the sanitation service in urban areas is about 68 %. In rural areas, the coverage rate of the sanitation service is very low (about 2%). Even in the localities where there is a sanitation operator, the latter serves only a portion of the population.

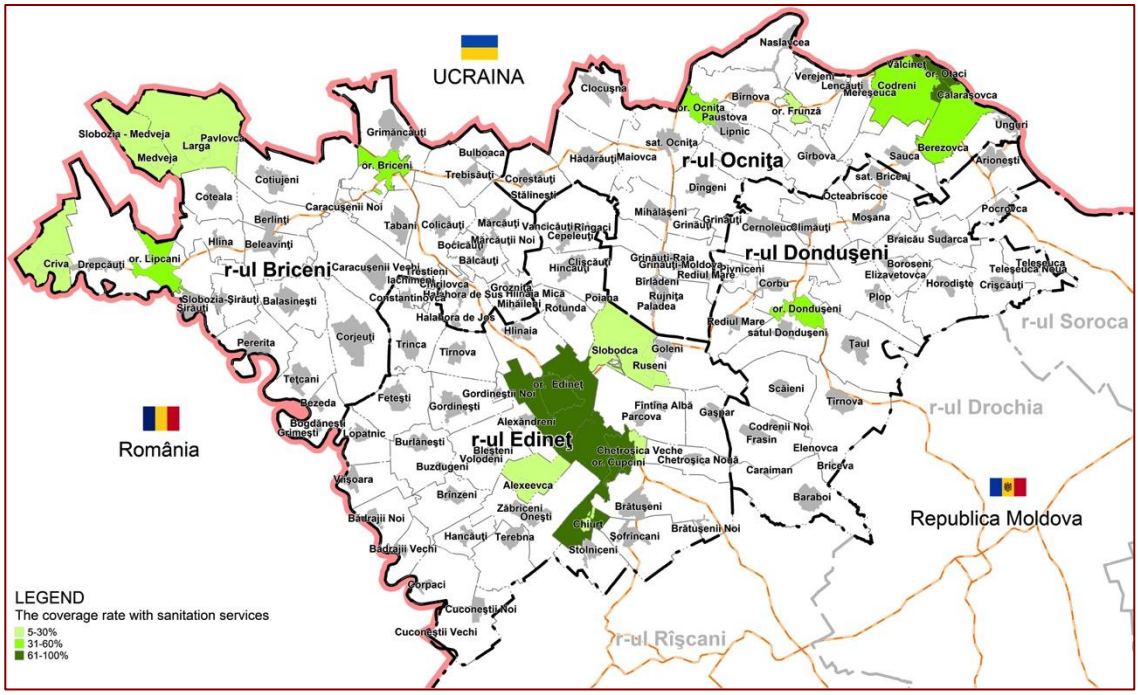
Table 5-2: The coverage rate of the sanitation service in WMZ 8, January 2017

	The coverage rate of the sanitation service (%)
Briceni rayon	**10**
Urban population	52
Rural population	1

Donduseni rayon	**13**
Urban population	60
Rural population	0
Edinet rayon	**25**
Urban population	76
Rural population	1
Ocnita rayon	**28**
Urban population	71
Rural population	5
Total WMZ 8	**20**
Urban population	**68**
Rural population	**2**

Source: GIZ/MLPS, based on the data provided by LPAs and the sanitation operators

Figure 5-2: Coverage rate with sanitation services, WMZ 8, January 2017



Source: GIZ/MLPS, based on the data provided by LPAs and by the sanitation operators

According to the data provided by sanitation operators, household waste is collected as follows:

- Urban areas:
  - Door-to-door collection for individual houses;
  - Collection points for blocks;
- Rural areas:
  - Door-to-door collection;
  - In collection points.

The collection frequency is twice a month for houses, and blocks 1-4 times/week.

The collection frequency for similar waste is upon the company's/institution's request.

The current situation on the recipients used for the mixed collection of household and similar waste owned by companies is presented below.

Table 5-3: Collection vessels for household waste, WMZ 8, January 2017

Rayon	Sanitation operator	LPA served	Type of collection recipient	Recipient volume	Number of recipients	Procurement year
Briceni	Î.M. Gospodăria Comunal-Locativă Briceni	Briceni	containers	1 m^3	100	2010
			bins	240 l	250	2014
	Î.M. Comprod-Lipcani	Lipcani	containers	1 m^3	140	2003
Donduseni	Î.M. "Apa-Canal" Donduseni	Donduseni	containers	0.7 m^3	33	2005
		Donduseni	containers	1 m^3	5	2015
Edinet	Î.M. DPGL - Edinet	Edinet	bins	120 l	1,370	2015
		Edinet	containers	1 m^3	126	2015
	Î.M. GCL Cupcini	Cupcini	containers	1 m^3	52	2016
	Î.M. Servicii Ruseni	Ruseni	bags			
	Î.M. Alexeevca	Alexeevca	bags			
Ocnita	Î.M. Apa Canal Ocnita	Ocnita	containers	1 m^3	100	2016
	Î.M. GCL Otaci	Otaci	bins	120 l	100	unknown
	Î.M. GCL Otaci	Otaci	containers	0.8 m^3	150	unknown
	Î.M. GCL Otaci	Otaci	containers	1 m^3	145	2016
	Î.M. GCL Frunza	Frunza	bags			
Total			**bins**	**120 l**	**1,470**	
			bins	**240 l**	**250**	
			containers	**1,1 m3**	**668**	
			containers	**0.7 – 0.8 m^3**	**183**	

Source: GIZ/MLPS, based on the data provided by LPAs and the sanitation operators

Table 5-4: Collection vessels for similar waste, WMZ 8, January 2017

Rayon	Sanitation operator	LPA served	Type of collection recipient	Recipient volume	Number of recipients	Procurement year
Briceni	Î.M. Gospodăria Comunal-Locativă Briceni	Briceni	containers	1 m^3	20	2010
	Î.M. Comprod-Lipcani	Lipcani	contaiers	1 m^3	50	2003
Donduseni	Î.M. "Apa-Canal" Donduseni	Donduseni	containers	0,7 m^3	33	2005
		Donduseni	containers	1 m^3	5	2015
Edinet	Î.M. DPGL - Edinet	Edinet	bins	120 l	130	2015
		Edinet	containers	1 m^3	470	2015
Ocnita	Î.M. Apa Canal Ocnita	Ocnita	containers	1 m^3	42	2016
	Î.M. GCL Otaci	Calarosovca	containers	0.5 m^3	21	unknown
	Î.M. GCL Otaci	Valcinet	containers	0.7 m^3	32	unknown
Total			**bins**	**120 l**	**130**	
			containers	**1,1 m^3**	**587**	
			containers	**0.5-0.7 m^3**	**86**	

Source: GIZ/MLPS, based on the data provided by LPAs and the sanitation operators

The majority of the recipients used for collecting household waste are bins (120 l and 240 l), more than 67%. This is due to the fact that the sanitation service currently occurs mainly in urban areas, with door-to-door collection for houses.

There is a small number of recipients used for collecting similar waste (803), about 16% bins and the rest containers. The most of the recipients used for collecting household and similar waste have been procured during the last five years.

The table below shows the current situation on the vehicles used for the transport of household and similar waste.

Table 5-5: Collection vehicles, WMZ 8, January 2017

Rayon	Sanitation operator	LPA served	Type of collection vehicle	Capacity of collection vehicle [m^3]	Number	Manufacturing year
Briceni	Î.M. Gospodăria Comunal-Locativă Briceni	Briceni	GAZ 330900	7	1	2011
			GAZ 3307	7	1	2005
			IUMZ6K	7	1	1998
			Tractor	4	1	1990
	Î.M. Comprod-Lipcani	Lipcani	GAZ 53	3,5	1	1989
Donduseni	Î.M. "Apa-Canal" Donduseni	Donduseni	GAZ 3307	7,2	1	2005
			GAZ 53	6,2	1	1987
			Tractor	5,5	1	1991
			Tractor	4	1	1989
			Tractor	4	1	1956

Rayon	Sanitation operator	LPA served	Type of collection vehicle	Capacity of collection vehicle [m^3]	Number	Manufacturing year
Edinet	Î.M. DPGL - Edinet	Edinet	GAZ 3309	4	2	2005
			IVECO	7	1	2005
			Tractor	4	1	1989
			Tractor	4	1	2003
			Tractor	4	1	2016
	Î.M. GCL Cupcini	Cupcini	GAZ 53	8	1	1981
			GAZ 3707	5	1	2004
			MAZ 45	13	1	2015
	Î.M. Servicii Ruseni	Ruseni	Tractor	4	1	1990
Ocnita	Î.M. Apa Canal Ocnita	Ocnita	GAZ 3309	15	1	2005
			Tractor	4	1	1998
	Î.M. GCL Otaci	Otaci	GAZ 3309	8	1	2007
			GAZ 53	4	1	2015
			GAZ 53	7	1	2015
			MERCEDES	20	1	2001
			GAZ 53	4	1	2010
			GAZ 52	2,5	1	2000
			GAZ 53	4	2	2002
Total			**Specialised collection vehicles**		**21**	
			Tractors		**9**	

Source: GIZ/MLPS, based on the data provided by LPAs and the sanitation operators

The eight sanitation operators in this zone own 21 special vehicles for waste transport and 9 tractors. Except for one tractor (acquired in 2006), all the other tractors are more than 25 years old.

Of the special vehicles, 5 were manufactured between 1981-1999, 11 were manufactured between 2000-2010, and 5 were manufactured between 2011-2016.

In the zone the separate collection of recyclable waste is not implemented yet.

5.4 Recovery of municipal waste

Considering the fact that there is no separate collection of recyclable waste, there are currently no sorting plants or other recovery facilities for recyclable waste in WMZ 8.

5.5 Disposal of municipal waste

At present, municipal waste is stored in 137 dumpsites, as follows:

- Briceni Rayon – 30 dumpsites, of which 2 have been authorised;
- Donduseni Rayon – 39 dumpsites, of which 24 has been authorised;
- Edinet Rayon – 38 dumpsites, of which 7 have been authorised;
- Ocnita Rayon – 30 dumpsites, of which 9 have been authorised.

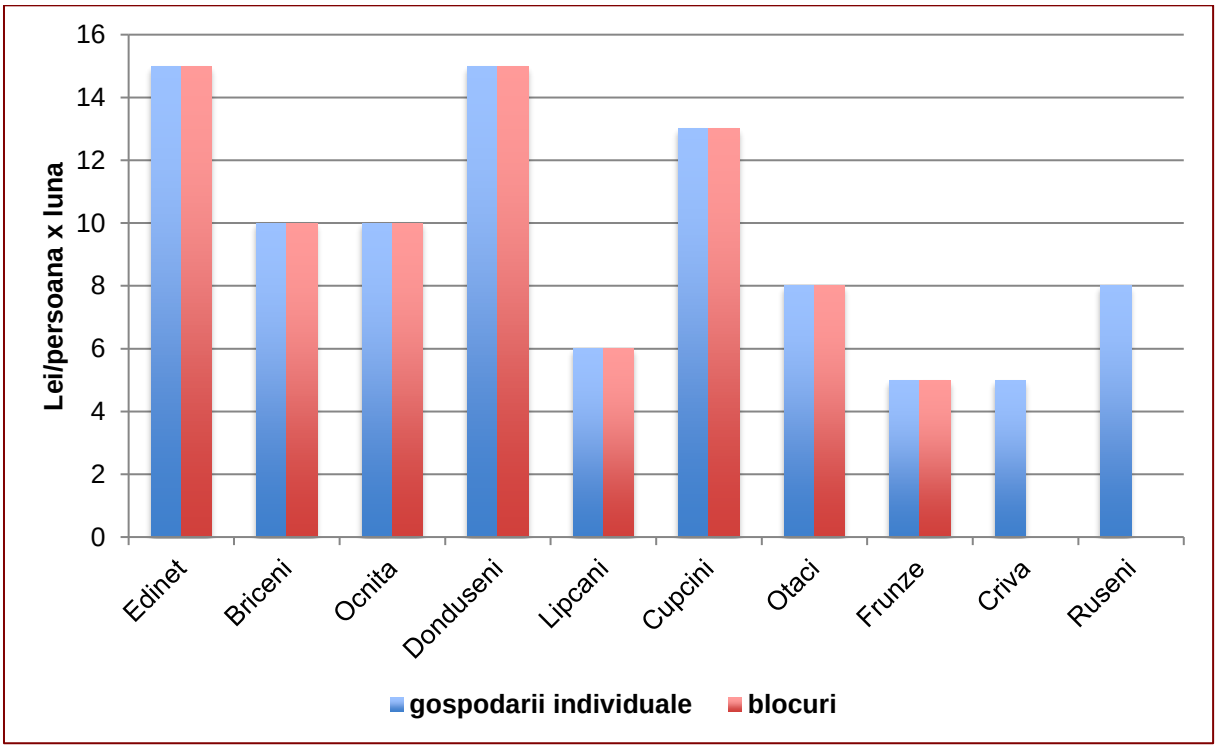
Details on the existing dumpsites are provided in section 9.

5.6 Financial aspects

The current payment mechanism of the sanitation service is mixed:

- Tax in Donduse city and rural localities served by: Î.M. Cricom-Service and Î.M. Servicii Ruseni;
- Tariff – in all the other LPAs.

Figure 5-3: The tax/tariff level for household waste, WMZ 8, January 2017



Source: GIZ/MLPS, based on the data provided by LPAs and the sanitation operators

At present, the level of the tax/tariff paid by domestic users in WMZ 8 is not the same. Figure 5-3 shows that the level of the tax/tariff is different for all the operators. Although the service provided is similar, mixed collection of waste and disposal in dumpsites, the cost paid by the users in urban areas differs from town to town.

The tariff paid by companies and institutions for the management of similar waste is between 80 – 150 MLD/m^3.

As a general conclusion, it can be stated that the level of the current tariff/tax paid for the sanitation service in WMZ 8 is not homogeneous and it is largely not correlated with the amount of generated waste. On the one hand, this is due to the lack of methodological norms for the substantiation of the sanitation service at the national level. On the other hand, this situation is due to the low level of the population paying for the service and to the fact that the amount of waste that is managed is not known (waste is not weighed as dumpsites are not equipped with weighbridge).

The table below shows the budgets for 2015 or 2016 of the operators managing household and similar waste in this zone, as well as the budgets allocated by LPAs, depending on the case, for the sanitation service.

Table 5-6: Budget allocated for the sanitation service, 2015/2016, WMZ 8

Rayon	Sanitation operator	Operator's budget (MDL)	Budget allocated by LPA (MDL)	Financial year
Briceni	Î.M.Gospodăria Comunal-Locativă Briceni		836,543	2015
Briceni	Î.M. Comprod-Lipcani		967,634	2015
Briceni	Î.M. Cricom-Service		7,200	2015
Briceni	Î.M. Prestservicii-Nord	126,900		2016
Briceni	Î.M. Medveja Service	No budget		
Donduseni	Î.M. "Apa-Canal" Donduseni	1,441,515	869,000	2016
Edinet	Î.M. DPGL - Edinet	2,300,000	600,000	2016
Edinet	Î.M. GCL Cupcini	896,300	200,000	2015
Edinet	Î.M. Servicii Ruseni		50,000	2016
Edinet	Î.M. Alexeevca	No budget		

Rayon	Sanitation operator	Operator's budget (MDL)	Budget allocated by LPA (MDL)	Financial year
Ocnita	Î.M. Apa Canal Ocnita	580,000	971,000	2016
Ocnita	Î.M. GCL Otaci	444,000	800,000	2016
Ocnita	Î.M. GCL Frunza	No budget		

Source: GIZ/MLPS, based on the data provided by LPAs and the sanitation operators

As it can be expected, the operators that are mainly active in urban areas have the largest budget. In three communes, the operators do not have a budget. In all cases with budget, except for Briceni town, money from the LPA budget is also allocated for the sanitation service every year.

5.7 Projects on waste management

Until now, a series of municipal waste management projects have been implemented in WMZ 8. Their main objective consisted in procuring collection and transport equipment, as well as building collection platforms.

Table 5-7: Municipal waste management projects implemented in WMZ 8

Rayon	Beneficiaries	Project name and description	Financed by	Project value (MLD)	Year of implementation
Briceni	Lipcani, Criva, Drepcăuți, Hlina, Șirăuți, and Slobozia Șirăuți	"*Consolidation and development of the sanitation service for a clean environment in Lipcani*" Setting up a communal intercommunity enterprise in order to provide sanitation services, snow cleaning and road maintenance, dumpsites maintenance, and electric networks maintenance. The communal service providing enterprise "Comprod-Lipcani" was reorganised and modernised, a multifunctional tractor was purchased (grader-bulldozer)	The Common Programme for Integrated Local Development financed by the United Nations Development Organisation	2,000,000	2015
Briceni	Briceni	250 waste bins of 240 litres	The United States Agency for International Development	111,000	2014
Edineț	Edineț	1500 waste bins of 120 litres	The United States Agency for International Development	544,000	2015
Edineț	Edineț	Waste transportation truck IVECO whose capacity is 2.3 tonnes	The United States Agency for International Development	-	2005
Edineț	Edineț	"*Different waste treatment –complex approach"* Trailer tractor, waste transportation truck, 156 containers	The European Commission and Edineț City Hall	2,904,965*	2007
Edineț	Cupcini	Waste transportation truck MAN 4370 (13 m^3)	The National Environmental Fund	680,000	2017
Ocnita	Otaci	Waste transportation truck GAZ 53 (7 m^3)	The United States Agency for International Development	840,000	2015
Ocnita	Otaci	Procurement of containers for collecting household waste, tip lorry and tractor - dozer	The National Environmental Fund	2,772,675	2015

Rayon	Beneficiaries	Project name and description	Financed by	Project value (MLD)	Year of implementation
Ocnita	Otaci	New Holland excavator	The United States Agency for International Development	1,000,000	2013
Ocnita	Otaci	Building waste collection platforms in Otaci town and in the villages Călărăşeuca, Berezovca, Vălcineţ, and Codreni	The National Environmental Fund	2,699,238	2012

Source: GIZ/MLPS, based on the data provided by LPAs and the sanitation operators

Two municipal waste management projects have been prepared lately in WMZ 8. One of them, the Lipcani project, has been approved and it is going to be funded from the National Regional Development Fund. The other one, the Donduseni project, has been included in the Regional Operational Programme, and the financing source is going to be identified. Both projects include also collection and transport equipment. With regard to waste bins for collecting residual waste, their number seems to have been estimated based on door-to-door collection in rural areas too. This option is not the same as the one chosen within this feasibility study, which provides collection points for residual waste collection in rural areas (see section 10.1).

In view of a unitary approach to the integrated waste management system in WMZ 8, the provisions of this Feasibility Study must be taken into consideration during the implementation of these two projects.

Table 5-8: Municipal waste management projects under preparation in WMZ 8

Rayon	Beneficiaries	Project name and description	Financed by	Project value, lei	Current status
Briceni	Lipcani, Criva, Drepcăuţi, Şireuţi, Slobozia-Şireuţi, Pererîta, Hlina, Coteala, Medveja, Cotiujeni villages, Larga commune	"*Establishing the integrated waste management system in 11 localities within the Briceni rayon*" Expected output: closing down 67 dumpsites, procurement of 4 waste collection trucks, 1 bulldozer, 1 trailer tractor, 219 containers of 1.1 m^3, 73 mesh containers of 1.8 m^3 (for the separate collection of plastic waste), 9,500 waste bins of 120 l for individual households, 1 baling press for plastic, building 73 waste collection platforms, and carrying out a public	The National Fund for Regional Development	23,137,927	2017-2020, the project has been approved, and the single programming document has been included

Rayon	Beneficiaries	Project name and description	Financed by	Project value, lei	Current status
		awareness campaign			
Dondușeni	Donduseni Town, villages: Corbu, Climăuți, Plop, Țaul, Dondușeni	"*Expansion of the solid waste management system in 6 localities within Dondușeni rayon*" Expected output: closing down 12 dumpsites, procurement of 2 waste collection trucks, 1 excavator-loader, 1 sanitation car, 1 motor grader, 1 tractor, 126 containers of 1.1 m^3, 42 mesh containers of 1.8 m^3 (for the separate collection of plastic waste), 4,500 waste bins of 250 l for individual households, 1 baling press for plastics, building 42 waste collection platforms, carrying out a public awareness campaign	This is going to be identified	14,708,800	The project has been evaluated and it has been included in the Regional Operational Programme

Source: GIZ/MLPS, based on the data provided by LPAs and the sanitation operators

6 Objectives and targets

In addition to the national planning document, the National Waste Management Strategy, presented in section 3, there are other planning documents at the regional level.

The Regional Sectorial Waste Management Programme for North Development Region as well as the one for North Development Region have been elaborated within the project "Modernizing Local Public Services in the Republic of Moldova", project implemented by the German Development Cooperation through GIZ and financed also by the Swedish International Development Cooperation Agency (Sida), the Romanian Ministry of Foreign Affairs, and the European Union. The Regional Programmes have been approved by the Regional Development Councils in February 2014.

The Regional Sectorial Waste Management Programme for North Development Region presents the following objectives underlying the implementation of integrated waste management systems:

- Collecting municipal waste – expanding waste collection services from urban areas to rural areas:
    - on the short term, 2013 - 2015 – coverage of collection services of 100 % in urban areas, and 75 % in rural areas;
    - on the medium term, 2018 - 2022 – coverage of collection services of 100 % in urban and rural areas;

- Recovery of resources:
    - on the short term, 2013 - 2017 – recycling 15 % of the packaging waste generated in rural areas and 25 % of the packaging waste generated in urban areas; elaborating and implementing pilot projects in order to prove the most efficient measures for the management of organic waste;
    - on the medium term, 2018 - 2022 – recycling 25 % of the packaging waste generated in rural areas and 35 % of the packaging waste generated in urban areas; recovery of 50 % of the organic waste generated in rural areas, and of 40 % of the organic waste generated in urban areas;
    - on the long term, after 2023 – recycling of 35 % of the packaging waste generated in rural areas, and of 45 % of the packaging waste generated in urban areas; recovery of 100 % of organic waste;
- Bulky waste:
    - on the short term, 2013 - 2017 – 40 % of the generated bulky waste is properly treated for recycling and/or disposal in safety conditions;
    - on the medium term, 2018 - 2022 – 55 % of the generated bulky waste is properly treated for recycling and/or disposal in safety conditions;

    - on the long term, after 2023 – 70 % of the generated bulky waste is properly treated for recycling and/or disposal in safety conditions;
- Construction and demolition waste:
    - on the short term, 2013 - 2017 – 40 % of the construction and demolition waste is properly treated for recycling and/or disposal in safety conditions;
    - on the medium term, 2018 - 2022 – 55 % of the construction and demolition waste is properly treated for recycling and/or disposal in safety conditions;
    - on the long term, after 2023 – 70 % of the construction and demolition waste is properly treated for recycling and/or disposal in safety conditions;
- Transfer stations and waste disposal:
    - on the short term, 2013 - 2017 – construction of one transfer station in each micro-zone. Reducing waste dumpsites to 1-3 sites per rayon. Starting building the compliant landfill and starting closure of the existing dumpsites;
    - on the medium term, 2018 - 2022 – one compliant landfill for each waste management zone together with the gradual closure /rehabilitation of the existing dumpsites;
    - on the long term, after 2023 – disposal of waste in a compliant landfill for each waste management zone.

Having analysed the objectives and the targets proposed by the Regional Sectorial Waste Management Programme for North Development Region together with those included in NWMS and in the new Law on waste, the following conclusions have been drawn:

- Coverage of sanitation services and separate collection of waste - NWMS provides for creating a waste collection system in urban/rural areas, together with introducing and expanding separate collection of waste until 2016. The Regional Programme provides for a 100 % coverage of the sanitation service in urban as well as in rural areas only on the medium term, for 2018-2022. The new Law of waste stipulates introducing separate collection systems for paper, metals, plastics, and glass until 2018;
- Recycling objectives - The Regional Programme has very ambitious recycling targets for packaging waste, organic waste, as well as for bulky waste and construction and demolition waste on the short term, as well as on the medium and long term. Targets for the recovery of organic waste are unrealistic (50% until 2022, and 100% as of 2023). The new Law on waste stipulates an objective preparing for the reuse and recycling of municipal waste of 30% by 2020. The law does not stipulate which calculation method of the four calculation methods included in the Commission Decision 2011/753/EU establishing rules and calculation methods for verifying compliance with the targets set in Article 11(2) of Directive 2008/98/EC of the European Parliament and of the Council shall be used in determining this objective;
- Building landfills and transfer stations - NWMS provides for building regional landfills and transfer stations between 2014 – 2017, while the Regional Programme stipulates that the construction of landfills will only be started between 2013-2017, and it will be completed between 2018-2022;
- Closure of the dumpsites – for 2014-2016, NWMS provides a reduction of the number of dumpsites at the regional level to 4-6, together with drawing up the closure plans. The Regional Programme stipulates reducing the number of dumpsites to 1-3 consolidated sites per rayon for 2013-2017.

As it can be noticed, the objectives included in the planning documents at the national and regional level, as well as those included in the new Law of waste have not been correlated. Furthermore, the recycling objectives provided in the Regional Programme are unrealistic considering the current situation (especially those concerning the recovery of organic waste). Also, according to the data presented in Chapters 4 and 5 the objectives set for 2017 have not been met.

Thus, considering the current waste management situation (see Chapters 4 and 5) as well as the provisions of the new Law on waste, the objectives and targets for WMZ 8 regarding the integrated waste management system that this Feasibility Study refers to were set (Table 6-1). The objectives and targets are set for 2021, which is the year in which it is assumed that the integrated waste management system will be implemented[7].
The objectives and targets for the management of specific waste flows are presented in section 7. After the implementation of the first phase (measures foreseen in this Feasibility Study), new targets shall be established for the development of the integrated waste management system while also considering the legislation in force at that time.

Table 6-1: Objectives and targets for WMZ 8 for 2021

Objectives	Targets			Remarks
	Description	Urban Area	Rural Area	
Increasing the area covered by waste management services	Coverage area by waste management services	100%	100%	The target in rural area is 100 % because it is assumed that the integrated waste management system in the zone will be in operation in 2020 and the municipal waste disposal shall be carried out only on the new compliant landfill
Increasing the recycling rate of municipal waste	Preparing for the reuse and recycling of paper, metal, plastic or glass household waste, as well as of other specific types of household waste or similar waste	30%		The objective is defined according to method 2 of the Commission Decision 2011/753/EU establishing rules and calculation methods for verifying compliance with the targets set in Article 11(2) of Directive 2008/98/EC of the European Parliament and of the Council. It is calculated as a ratio of the recycled quantity of paper, metal, plastic, or glass waste and other specific waste flows resulting from households or similar waste out of the total generated quantity of paper, metal, plastic or glass waste and other types of specific waste flows resulting from households or similar waste.
Increasing the recovery of biodegradable	Promoting of composting and home composting	Composting of the green waste in	Promoting home composting	During the development of the integrated waste management system new capacities for the biological treatment of

[7] The actual start of the integrated waste management system will depend on a number of factors, including: adequate financing or co-financing has been identified and is available, institutional and organisational solutions have been agreed and implemented, and construction has begun by the end of 2018. Regardless of when the system is actually implemented, the waste management targets – including dates for their achievement – are required in order to identify the configuration of the most cost-effective waste management service.

Objectives	Targets			Remarks
	Description	Urban Area	Rural Area	
municipal waste to ensure diversion from landfilling		urban area	in rural area	municipal waste shall also be developed
Reducing the environmental impact produced by waste disposal	Compliant disposal facility in place and ceasing the activities of the non-compliant facilities	One compliant regional landfill in operation		
		Ceasing of the activities of all the dumpsites		The activity of the dumpsites shall be ceased and closed correlated with the plan for the transitional waste disposal sites and the commissioning of the regional compliant landfill

Source: GIZ/MLPS

7 Management of special waste streams

7.1 Hazardous household waste

In accordance with the European Waste List, the following separately collected household waste flows are considered as hazardous waste:

- Solvents;
- Acids;
- Bases;
- Photographic chemical substances;
- Pesticides;
- Fluorescent tubes and other waste containing mercury;
- Abandoned equipment containing CFC (Chlorofluorocarbons);
- Oils and greases, other than edible oils and greases;
- Paints, inks, adhesives and resins containing dangerous substances;
- Detergents containing dangerous substances;
- Cytotoxic and cytostatic medicines;
- Batteries and accumulators with lead, Ni-CD and mercury content and unsorted batteries and accumulators containing these batteries;
- Electrical and electronic equipment disposed of, other than fluorescent tubes and other than waste containing mercury and abandoned equipment containing CFC, containing dangerous components;
- Wood with a low content of dangerous substances.

The *Waste Management Strategy in the Republic of Moldova* includes in its general objectives an objective regarding specific waste flows, namely: the development of collection and treatment systems for specific waste flows (packaging, WEEE, tyres, batteries, etc.) by promoting and implementing the “producer responsibility” principle and for hazardous waste (medical waste, used oils, etc.) it is foreseen to develop one collection point for each at regional level.

The Regional Sectorial Programme for Waste Management states that hazardous waste must be properly managed, that is it must be collected separately from other types of waste, and it must be sent to companies authorised for treatment of this type of waste. The Programme also states that producers, together with the competent authorities, shall set up a national system for the proper collection and treatment of hazardous waste. It also states the fact that transfer stations and regional landfills can provide areas for the temporary storage of hazardous household waste, and shall be equipped with special containers.

Law 209/2016 on waste, which will be in force in December 2017, includes a series of provisions on hazardous waste.

With regard to waste control, it states that hazardous waste shall be generated, collected, transported, stored, and treated based on an environmental permit.

The Law also includes provisions on the interdiction to mix hazardous waste and on labelling of such waste. With regard to hazardous household waste, the Law states the fact that the provisions on control, the interdiction to mix it, and on labelling hazardous waste do not apply to mixed waste resulting from private households. Provisions on labelling hazardous waste do not apply to separate fractions of hazardous waste from private households as long as collection, disposal or recovery of such waste has not been accepted by an authorised company or one that has been registered according to the provisions of the law.
The Law provides setting up the hazardous waste management centre in art. 62. This is going to be a hazardous waste management company, a distinct legal entity provided with a separate budget, subordinated to the central environmental body of the public administration. The purpose of the Centre is collecting hazardous waste and sending it to treatment.

The Ministry of Environment, by means of the Office for the Prevention of Environmental Pollution, has prepared the Feasibility Study for setting up the Hazardous Waste Management Centre (the Centre), located in Sangera town, Chisinau municipality. At present, the EIA is going on.

Based on the provisions of the EIA Report[8], building a hazardous household waste collection system for municipal waste has been planned within the Centre, together with a proper management of hazardous waste. Collection of hazardous household waste will occur in mobile points, by special cars belonging to the Centre. In addition, the collection and temporary storage of hazardous waste in stationary points have been envisaged. These points will be located on the regional landfills sites that are going to be built. It is mentioned that local public authorities are responsible for setting up these temporary storage areas. The storage capacity must be at least 10 tonnes.
If we consider that hazardous municipal waste stands for 5% of all municipal waste, as the EIA Report states, it follows that a maximum quantity of about 250 tonnes is going to be generated in WMZ 8 in the project implementation year, 2021.

Considering the provisions of Law 209/2016 on waste, as well as the already started project in order to set up the National Hazardous Waste Management Centre, within the Integrated Waste Management System system, an area shall be provided for the collection and temporary storage of municipal hazardous waste on the regional landfill site. The temporary storage area shall be equipped during the operation stage, correlated with the operation of the National Hazardous Waste Management Centre.

[8]http://www.mediu.gov.md/images/Anunturi/DEIM%20finală%20-%20Centrul%20de%20Management%20a%20Deșeurilor%20Periculoase%20din%20or.Sîngera.pdf, accessed in March 2017

7.2 Bulky waste

Bulky waste is the type of municipal waste, which either due to its large mass or because of its high volume cannot be taken over by the regular waste collection system. The main examples of bulky waste are furniture and mattresses.
The *Waste Management Strategy in the Republic of Moldova* envisages no specific objectives or measures regarding bulky waste management.

T*he Regional Sectorial Programme for Waste Management* provides targets regarding bulky waste, namely proper treatment in view of recycling and/or safe disposal: 40% on the short term, 2013-2017, 55% on the medium term, 2018-2022, and 70% on the long term, starting with 2023.

No additional investments are needed for the collection and transport of bulky waste. The collection of this type of waste shall be carried out based on a schedule established at the beginning of the year by the sanitation operator and which shall be communicated both to the domestic and non-domestic users. The inhabitants will take out the waste and place it in front of their houses or in the case of the blocks of flats will take it to the bulky waste collection points, in accordance with the collection schedule.
The sanitation operator shall transport the collected bulky waste to these spaces using the existing transport means (for example tractors).
Specific provisions regarding the management of bulky waste shall be included in the contract with the sanitation operator.

7.3 Packaging waste

The *Waste Management Strategy in the Republic of Moldova* includes in its general objectives an objective regarding specific waste flows, namely: the development of collection and treatment systems for specific waste flows (packaging, WEEE, tyres, batteries, etc.) by promoting and implementing the “extended producer responsibility” principle.

The Regional Sectorial Programme for Waste Management includes in terms of action for 2014-2018 the preparation of implementation mechanisms regarding the “extended producer responsibility” principle for all waste flows, including special waste flows (batteries and accumulators, used tyres, packaging waste, WEEE, as well as end-of life vehicles). Besides, the Programme includes recovery targets for packaging waste:

- On the short term 2013-2017 – 15 % in rural area and 25% in urban area;
- On the medium term 2018-2022 – 25% in rural area and 35% in urban area;
- On the long term starting with 2023 – 35% in rural area and 45% in urban area.

Although it hasn’t been clearly stated, we can infer that these targets refer to municipal packaging waste.

Law 209/2016 on waste, which is going to take effect in December 2017, includes provisions on packaging and packaging waste (art. 54).

Also, the Law states the general requirements regarding the extended producer responsibility in art. 12. The following waste flows are mentioned: waste of batteries and accumulators, waste of electric and electronic equipment, decommissioned cars, used oils and packaging waste. The implementation mechanism regarding the extended producer responsibility shall be established within specific normative acts regarding the management of such types of waste, approved by the Government.
In 2016, the Government Decision project regarding the approval of the Regulation on packaging and packaging waste was published for public consultations on the official website of the Ministry of Environment.
The Regulation project largely transposes the provisions of Directive 94/62/EC on Packaging and Packaging Waste, further amended and completed.

The GD project includes provisions on the implementation of the extended producer responsibility scheme, as well as the objectives, staged for 2018-2025, both for recycling per each type of material, as well as the global recycling and recovery objectives.
Producers can carry out their responsibilities individually or in a collective system authorised by the central public authority for environmental protection.

With regard to packaging waste included in municipal waste, the GD project states in art. 19, that collective systems shall ensure collection of packaging waste from sorting stations, and they shall pay to administrative – territorial units the difference between the collection, transport, temporary storage and sorting costs and the revenues resulting from the sales of these materials. They shall be responsible for recovery of these materials.

Until the date of the elaboration of this Feasibility Study, the GD project has not been approved yet. Thus, the financial responsibility of packaging producers has not been taken into account within the cost – benefit analysis. However, we should mention the fact that the application of the packaging extended producer responsibility according to the GD project would have a considerable positive impact on the implementation of the integrated waste management system, namely it would result in a decrease of the tariff to be paid by the population.

Following the approval of the Regulation on packaging and packaging waste, the Ministry of Environment must make sure that the provisions will be taken into consideration during the implementation of the projects on integrated waste management systems in the 8 zones. Also, the implementation of the packaging extended producer responsibility scheme must be considered when established by the Ministry of Environment, the Ministry of Finance, and the international financial institutions.

7.4 Waste electrical and electronic equipment and waste batteries and accumulators

The *Waste Management Strategy in the Republic of Moldova* includes in its general objectives an objective regarding specific waste flows, namely: the development of collection and treatment systems for specific waste flows (packaging, WEEE, tyres, batteries, etc.) by promoting and implementing the "extended producer responsibility" principle. Furthermore, specific objectives for waste electrical and electronic equipment and waste batteries and accumulators are envisaged, namely:

- Waste electrical and electronic equipment:
  - Ensuring a network for the collection / recovery of waste electrical and electronic equipment;
  - Ensuring the possibility that the last owner of the electrical and electronic equipment is able to hand it in free of charge to a collection / recovery unit;
  - Extending the reuse and recycling of the materials from the electrical and electronic equipment.
- Waste batteries and accumulators:
  - Ensuring a network for the collection of waste batteries and accumulators from the users / population through automobile service stations;
  - Ensuring the fact that the waste batteries are managed adequately or they are recycled or landfilled.

The Regional Sectorial Programme for Waste Management includes in terms of actions for 2014-2018 the preparation of implementation mechanisms regarding the "extended producer responsibility" principle for all waste flows, including special waste flows (batteries and accumulators, used tyres, packaging waste, WEEE, as well as end-of life vehicles).
Law 209/2016 on waste, which is going to take effect in December 2017, includes provisions on the management of batteries and accumulators waste (art. 49), and on the management of electric and electronic waste (art. 50).

Besides, the law states the general requirements regarding the extended producer responsibility in art. 12. As mentioned in the section on packaging waste, the law stipulates the waste flows taken into consideration for the extended producer responsibility, including batteries and accumulators, as well as electric and electronic equipment waste. As with packaging waste, the implementation mechanism of the extended producer responsibility will be established in specific normative acts regarding the management of such types of waste, approved by the Government.
In 2016, the following were published for public consultations on the Ministry's of Environment website:

- Governmental Decision project regarding the approval of the Regulation on batteries and accumulators and such waste;
- Governmental Decision project regarding the approval of the Regulation on WEEE.

Both regulation proposals mainly transpose the provisions of the European directives and include provisions on the operation of the extended producer responsibility scheme.

Producers together with local public authorities are responsible for organising the separate collection of WEEE as well as of portable batteries and accumulators waste resulting from households.
By the date of the elaboration of this Feasibility Study, the two GD projects have not been approved yet.

Due to the fact that the National Waste Management Strategy, as well as the Law on waste and the draft Regulations envisage the promotion and implementation of the "producer responsibility" principle, the Feasibility Study does not envisage specific investments regarding the collection of waste electrical and electronic equipment and waste batteries and accumulators. The collection points for these waste flows from the population shall be established in cooperation with the producers or producer responsibility organisations.
Specific provisions regarding the collection, transport and handover in view of recovery/ disposal of waste electrical and electronic equipment and waste batteries and accumulators from private households shall be included in the contract with the sanitation operator.

7.5 Construction and demolition waste

The construction and demolition waste, which in accordance with the European Waste List, are a particular waste category, may result from industrial and commercial construction and demolition activities, from infrastructure development activities or from construction and demolition activities carried out by the population.
The *Integrated Solid Waste Management Strategy for Development region South* envisages, as mentioned in chapter 5, targets regarding construction and demolition waste, namely:

- 2015 – 40% of the construction and demolition waste shall be treated adequately;
- 2020 – 55% of the construction and demolition waste shall be treated adequately;
- 2025 – 70% of the construction and demolition waste shall be treated adequately.

Also, *the Regional Sectorial Programme for Waste Management* provides targets for construction and demolition waste, namely proper treatment for recycling and/or safe disposal: 40% on the short term, 2013-2017, 55% on the medium term, 2018-2022, and 70% on the long term, beginning with 2023.
Law 209/2016 on waste, which is going to take effect in December 2017, provides in art. 14 (1) c), that preparation for reuse and other material recovery operations, including back-filling operations using waste in order to replace other substances, non-hazardous waste resulting from construction and demolition works, except for natural geological materials, must reach the level of minimum 55% of the total weight by 2020.

For the management of construction and demolition waste from private households, the Feasibility Study proposes 4 m^3 collection containers to be purchased. The collection of these types of waste from the population shall be carried out upon request, by providing the collection container / containers.

The sanitation operator shall transport the construction and demolition waste using the existing equipment (for example tractors).
Specific provisions regarding the management of construction and demolition waste from the population shall be included in the contract with the sanitation operator.

7.6 Manure and agriculture waste

In compliance with the European Waste List, the agricultural waste, including animal waste is a distinct waste category, not being included in the municipal waste category.
The *Waste Management Strategy in the Republic of Moldova* includes in its specific objectives ones regarding vegetal waste, animal waste and waste from wood processing:

- Encouraging the recovery through aerobe and anaerobic processes and construction of capacities for waste composting and fermentation, at least one per rayon;
- Supporting energy recovery, where material recovery is not feasible from a technical – economic point of view under safety conditions for the population and environment.

The *Integrated Solid Waste Management Strategy in Development Region South* specifies that agricultural waste also includes animal waste, which is a significant part of the agricultural waste. The Strategy envisages that by the end of 2013 no animal waste should reach the existing landfills, that these should be collected and treated separately. The most popular treatment method is composting, either using the individual composting system or the centralized composting plants.

The Regional Sectorial Programme for Waste Management provides the separate collection of manure and vegetal waste within the action plan. The Regional Development Agency and the local public authorities are jointly responsible for this measure, and it should be implemented between 2016-2019.

The information gathered during the elaboration of the study on the analysis of household waste in urban and rural area show that the sanitation operator is not permitted to collect the animal waste together with the household waste. The animal waste is separately collected, on a certain day and it is still landfilled on the dumpsite of the village.

Considering all of the above, this Feasibility Study does not envisage investments for the management of manure and agricultural waste, which are, as previously mentioned, not municipal waste. This waste flow must be separately collected from household waste and financing sources must be identified for their separate treatment, as envisaged by both the national and regional planning documents.

8 Option analysis

8.1 Assumptions and methodology

Options for development of the integrated waste management system in WMZ 8 have been analysed with regard to:

- Collection and transport of residual waste;
- Collection and transport of recyclables;
- Transfer and long distance transport;
- Sorting of waste;
- Treatment of biodegradable waste;
- Disposal of waste.
-

The methodology used for developing the options for establishment of integrated waste management system in WMZ 8 is based on the following main criteria:

- Analysis of the existing waste management situation;
- Assessment of current and future needs in waste management;
- Objectives and targets established according to the national and European legislation;
- Analysis of technically applicable options based on best practices available and EU standards;
- Analysis of technically applicable options with regard to their affordability and local applicability;
- The perspectives of the stakeholders, expressed during site visits and meetings.

The options analysis is based on the main assumption that waste management services in WMZ 8 are going be delivered on regional basis, instead of provision of waste services by each local public authority.

The specific assumptions related to the different technical options are included in the sections of the separate system elements.
The costs estimates are provided on annual basis for the planning period 2021 – 2040.

The cost calculations are prepared under the following conditions:

- The cost estimates are carried out in real terms and expressed in constant 2017 values, i.e. without consideration of inflation;
- The costs are calculated separately for the different activities, e.g. municipal waste, separate collection;
- All calculations are prepared in EUR;
- Costs are calculated without VAT;
- The following investment costs are taken into account for the cost calculations:
- The capital costs associated with infrastructure investments;
- Provision for future investment cost related to asset replacement;

- Depreciation - for the purposes of calculating annualised costs, capital investment costs have generally been depreciated over periods that reflect the typical economic operating life of the asset;
- Operating costs.

The operating and maintenance costs of the newly introduced systems are calculated based on the envisaged technologies and assumptions of level of labour, prices for consumables, etc. The operating costs for waste management are calculated on components and facilities and on cost items: maintenance and repair; labour; consumables; administration; taxes and insurance.

Discounted cash flows analysis is also used to calculate and compare the unit costs per tonne of waste for the different alternatives and for the individual components of each alternative. These are calculated for each cost category and for each rayon. Unit costs calculated in this way are indicators of the tariffs that would be needed (before VAT) to recover the costs in full of each scenario or scenario component over the reference period.

8.2 Technical options for collection and transport of recyclable waste

8.2.1 Current situation

There is no separate collection of recyclable waste in the project region. The recycling activities are limited to the collection of waste paper and scrap metal by informal sector in urban areas.

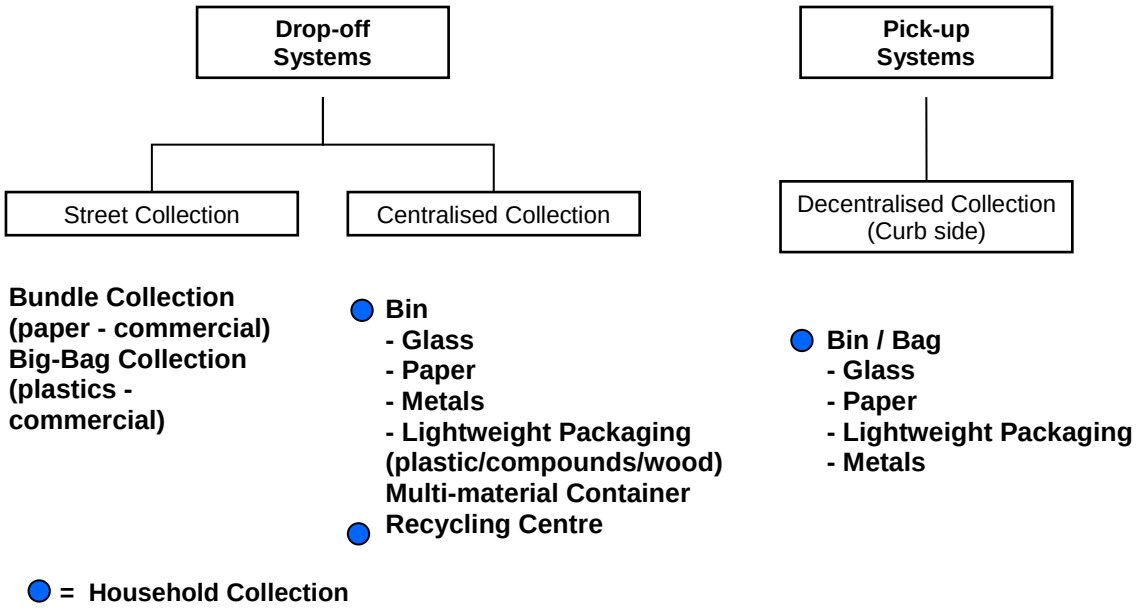
8.2.2 Territorial scope of the separate collection system

The objective to increase the recycling rate of municipal waste to 30% starting with 2021 presume that the separate collection of recyclable waste shall be organized in the entire WMZ. Considering that the majority of the population lives in rural areas, the achievement of this objective is not possible if separate collection is established only in urban areas. The proposed approach is also in line with the objectives set in the Regional Sectorial Waste Management Programme for North Development Region to recycle at least 35% of the packaging waste in rural areas and 45% of the packaging waste generated in urban areas by 2023.

8.2.3 Waste storage equipment and systems for collection

The system of separate collection of recyclables includes identification of the type of separate waste collection system. Basically, there are two main forms of collection – door-to-door collection and bring system. With regard to the type of collection system (door-to-door collection or bring system), different types of waste storage equipment can be used. The different collection systems are associated with different quality of the collected recyclables and with different costs.

Figure 8-1: Different systems for separate collection of recyclable waste



Source: GIZ/MLPS

Both types of collection schemes have been successfully implemented in different European cities. The decision whether to implement drop-off or kerb-side collection schemes depends mainly on the collection rates to be achieved but it is also linked with how the residual waste collection is organised, the tariff system in place, people's behaviour, scavengers and many other factors.

The choice of collection system has a significant impact on the costs and the quality of the collected materials.

There are few general rules, which shall be taken into account when deciding about the appropriate system:

- The bring systems require more efforts from citizens to reach the containers and discard sorted fractions. It is also very important that in this case the person discarding waste is anonymous and relatively high level of impurities and even residual waste must be expected. In practice that means a lower public participation than at kerb-side systems, lower amounts collected and higher amounts of sorting rejects obtained.
- The kerb-side collection systems achieve higher collection rates compared to the bring systems but they are more expensive. It's also important that the quality of the collected materials is higher in case of kerb-side collection.
- In general kerb-side collection needs to be applied in case that recycling and recovery targets cannot be achieved via the drop-off system or when there is limited time available to convince residents to participate in the separate collection.
- Another very important issue is that once a kerb-side system is established using individual bins or plastic bags, it is extremely difficult to switch to a drop-off system collection and convincing people to walk longer distances to discard their waste.
- The same applies for the number of sorted fractions. Once people get used to sorting plastics, paper and metals together and discarding them into one bin, it is difficult to convince them to start sorting these materials separately and throwing them into

separate bins.

Another important decision to be taken is the container types to be used. The size of container has impacts on quantity, composition (quality), volume, weight and unit size of waste collected.

The table below presents analysis of the advantages and disadvantages of the different options for separate collection of recyclables.

Table 8-1: Advantages and disadvantages of separate waste collection systems

Collection system		Collected volumes	Content of residues	Costs	Remarks
Door-to-door collection (plastic bags)		Average to high	Low	High	Collection schedule for plastic bags and collection of plastic bags shall be defined. Difficult compatibility with individual collectors and potential problems with stray dogs.
Door-to-door collection (individual bins)		High	Low to average	High	Suitable mainly to areas with individual houses or where container can be designated to a specific building.
Bring system (1.1 m^3 containers with wheels)		Average	Average	Low	Same collection vehicles like for residual waste can be used. The system results can be significantly influenced by type of containers used and awareness campaigns implemented.
Bring system (Igloo type containers for separate collection)		Low	Low	Average	Higher costs compared to 1.1 m^3 containers. Needs specialized collection vehicle with crane.
Bring system (Mesh containers)		Average	Low	Average	Suitable mainly for collection of PET bottles and to a less extend for paper and cardboard. Labour intensive if container shall be emptied manually.
Bring system (buy-back centres)		Low	Low	Low to average	The collected amounts can be higher if material is delivered to recycling centres from individual collectors. Suitable for paper and glass, less suitable for plastics.

Source: GIZ/MLPS (pictures: Ecopack Bulgaria, ARA Austria, Expert team photos from Leiptzig and Tel Aviv)

Based on the above analysis it can be concluded that:

- The option with plastic bags is the highest cost option of all as it necessitates a significant investment in purchasing and distributing bags to households. Taking into consideration that significant investments are needed for procurement of equipment for general waste collection, the higher overall cost for plastic bags make them an inexpedient choice at present. The option is also not suitable for collection in rural areas because of the difficult access;
- As noted before, the plastic 120 l waste bins are very suitable for waste collection from individual households, and certainly for separate collection of dry recyclables. However, like with plastic bags, their high overall investment and operational costs make them an inexpedient choice at present too. The system with individual bins can only be implemented in case that the collection of residual waste is organized in a similar way.
- Additional obstacles for implementing a door-to-door collection sheme for recyclables are the bad conditions of local roads and the difficult access to some of the houses in rural areas;
- The main advantage of the bring system with larger containers is the quick loading and the sufficient capacity. This leads to reduction of the operating costs. When located appropriately in the residential areas and in proximity to the main commercial/administrative centres, the collection rates could be increased;
- Buy-back centres are an efficient way of materials recovery as the quality of materials collected is of highest rate. This system however is not suitable for collection in rural areas;
- The implementation of separate collection using standard 1.1 m^3 containers with wheels will have significant advantages in comparison with other types of containers because of the lower implementation costs and the possible use of the same collection vehicles like these for collection of residual waste.

Taking into consideration the significant investments needed for provision of waste collection service to the entire rural population of WMZ 8, it is recommended that the expansion of the separate waste collection system is based on bring system as a lower cost option.
The following assumptions have been made for an estimate carried out of recycling rates which can be achieved and the related costs:

- Separate collection of recyclable waste will be implemented in the entire service zone by 2021;
- The separate collection is expected to achieve the following collection rates measured towards the household waste generated: 35% for paper and cardboard, glass and metal and 20% for plastics. The collection rates will grow with grow with 5% on annual basis till 2025 and then with 1% for the remaining period;
- The waste will be collected with rear-end collection vehicles from the same type like these used for the collection of mixed waste. Use of same vehicle for the different materials collected will be allowed;
- The collection trucks will operate in one 8 hour shift, five days in a week.
-

8.2.4 Options for separate waste collection

On the basis of all considerations above, the following two options have been identified, analysed and cost detailed with regard to their applicability to local conditions and target to extend the separate waste collection and increase the resource recovery rates in WMZ 8:

Table 8-2: Options for separate collection of recyclables

Options	Description	Advantages	Disadvantages
Option 1 	The separate collection will be implemented in 3 coloured plastic 1,1 m^3 containers: • for paper and cardboard; • for plastics and metals; • for glass. The service of the containers will be provided with 16 m^3 rear-end loading collection vehicle	Low implementation costs Use of standard collection equipment Simple sorting technologies for waste collected.	Possible contamination of collected material if residual waste is discarded in the containers
Option 2 	All recyclables will be collected in one plastic 1,1 m^3 containers (dry/wet system). The collection frequency will be once per week.	Low implementation costs Use of standard collection equipment More difficult sorting compared to Option 1. Less efforts for households to separate waste to different fractions at home.	Higher contamination of material compared to Option 1. Collection of glass in the same container with plastic and paper

Source: GIZ/MLPS, pictures: Ecopack Bulgaria

As alternative to the above options in between solution can be considered where paper and plastics are collected in common container and separate container is provided for glass. Each collection point in this case will comprise of three containers – two for mixed recyclables and one for glass. This option will have the same implementation costs as Option 1 and for that reason is not considered separately.

In order to define the equipment needed for separate waste collection, the following assumptions are used:

- The numbers and capacities of necessary collection containers and vehicles correspond to the quantities of waste collected, calculated through the number of residents served and the per capita recyclable waste collection rates in urban and rural areas for the respective year;
- The density of materials in the containers are assumed to be: 0.125 tonne/m^3 for paper and cardboard; 0.030 tonne/m^3 for plastics; 0.150 tonne/m3 for metals; 0.300 tonne/m^3 for glass and 0.240 tonne/m^3 for residues (impurities) contained in the separately collected waste;
- The impurities (residues) in separate collection containers is assumed to amount of

30% of the valuable materials.

- The average filling of the container is assumed to be 70%;
- The number of containers are calculated assuming 5% reserve;
- Time for lifting of 1 container is 2 minutes on average (incl. time for travelling to the next container).
- Travelling speed of collection trucks to the sorting facility is assumed at 35 km/hour;
- Maintenance costs for trucks are estimated at 5% of their investment costs;
- The annual maintenance costs for the containers are accepted to be 2% of the investment costs;
- The collection frequency will be 52 times per year for paper and cardboard and plastic containers (or dry container in Option 2) and 12 times per year for glass containers;
- 85% utilization of nominal collection vehicle payload and 85% availability are assumed when defining the necessary number of the collection vehicles;
- The lifetime for containers and bins is accepted 7 years and 10 years for RCVs;
- The unit costs of 150 €/pcs are used for 1.1 m3 plastic container and 130,000 €/pcs for 16.0 m3 collection vehicle. The costs for the container slabs are not taken into account;
- The average travelling distances between the individual cities/rayons and the sorting facility is measured towards the respective city centre. It's assumed that the sorting facility will be situated at the regional landfill;
- Average time spent for unloading at the sorting site will be half hour. The buffer time between the trips will also be half hour;
- The labour costs are calculated for 46 working weeks per person, 5 working days per week and 5% sick leave on average;
- Costs for the public awareness are estimated to the amount of 10% of the annual costs;
- Costs for the administration of the system 10% of direct operating costs.

The table below presents the two options with details in terms of equipment needed, population covered and the quantities of recyclables collected.

Table 8-3: Equipment needed and service cover (2021)

Type of waste collection equipment	Number of waste collection equipment	
	Option 1	Option 2
Separate collection containers 1,1 m^3	1,555	936
Separate collection trucks 16 m^3	0/4[9]	0/4

[9] Reserve trucks used for the residual waste collection will be sufficient for the service delivery (i.e. no additional trucks required)

Type of waste collection equipment	Number of waste collection equipment	
	Option 1	Option 2
Population covered	209,836	209,836
Quantity collected (tonnes)	3,597	3,597
Quantities recycled (tonnes)	3,082	3,082

Source: GIZ/MLPS

As seen from the table above, both options achieve the same recovery rate.

8.2.5 Cost comparison of the options for separate waste collection

The results from the analysis of costs and the recovery rates related to implementation of the different options are presented in the following (2021 used as a reference year).

Table 8-4: Cost comparison of the options for separate waste collection

Costs and recovery rate	Costs in EUR	
	Option 1	Option 2
Investment cost	**363,000**	**270,000**
Containers	233,000	140,000
Vehicles	130,000	130,000
O&M costs	**77,900**	**67,700**
Average incremental costs, EUR/tonne generated	4.46	3.66
Average incremental costs, EUR/tonne recycled	43.01	35.27
Recovery rate (from total waste)	7.7%	7.7%

Source: GIZ/MLPS

The O&M include costs for personnel, fuel, oil and maintenance costs for equipment. The annual costs include O&M costs and costs for annual depreciation of containers and vehicles.

8.2.6 Conclusion

As seen from the table above, Option 2 has lower implementation costs compared to Option one, mainly because of the lower number of containers required. Despite of that, considering that costs differences are not significant, the Option 1 will be recommended for further implementation because it provides higher flexibility for the operation and has significant advantages in with regard to the sorting of collected fractions.
Nevertheless, the above planning is more theoretical and considerable uncertainties exist at the present stage. The major issues that need to be addressed are:

- the composition of municipal waste and the potential for recycling;
- the role of the individual collectors and the possible interferences that can occur between the separate collection and the informal sector;
- the willingness of people to separate at source.

The above factors can considerably influence the recycling rates to be achieved and the planned revenues from the sales of recyclable materials.

8.3 Technical options for collection and transport of residual waste

The options for collection of residual waste are based on the analysis of the existing situation and practices and are developed with regard to the target to extend the waste collection service to the entire population of WMZ 8.

The collection and transportation system consists of the following elements:

- The pre-collection system;
- The container placement and the provided container volume, if the pre-collection system is based on a container system;
- The collection frequency per week;
- The truck type, which is used for collection and short distance transportation;
- Collection shifts.

The collection system shall also take into account the location of the selected site for future regional landfill, the relief of the region and roads condition.
The different elements are closely interlinked. Therefore a final recommendation only can be made for complete collection and transportation systems.

8.3.1 Current situation

Waste collection services are organized in all towns in the project region and cover approximately 68% of the population living there. In rural areas collection of municipal waste is provided in very limited number of settlements and the service coverage is approximately 2%. The collection urban area is organized through collection points for the blocks of flats and door-to-door collection for some of the individual houses. In rural areas both systems apply.
The frequency of waste collection is different for blocks of flats and for individual households and varies from operator to operator. The waste generated by persons living in the blocks of flats is collected 1 – 4 times per week, while the waste generated by persons living in individual houses are collected twice per month. For public institutions and companies the waste collection services is offered by request or once per week.
The waste management operators in WMZ 8 have different collection bins. The majority of the recipients used for collecting household waste are bins (120 l and 240 l) and 1.1 m^3 containers. A total number of 668 containers of 1.1 m^3 are available in WMZ 8 along with 250 bins of 240 l and 1,470 bins of 120 l. These are used for servicing the households. Another

587 containers of 1.1 m^3 and 130 bins are used for public institutions and businesses. Limited number of box type metal containers of 0.5 – 0.7 m^3 are also used for providing service.
Significant number of recipients was procured in the period 2014 – 2016 and will be in use at the time when the new waste management system will be in place.

8.3.2 Pre-collection system

A comparison of different pre-collection system types is presented in the following table.

Table 8-5: Comparison of different pre-collection systems

	Type 1: Bag collection	Type 2: Individual Bins and Containers	Type 3A: Street collection point wheeled Euro-container 1.1 m³	Type 3B: Street collection point fixed container 1.8, 2.4 and 3.6 m³	Type 4 Skip containers 4.0 m³
Short description	 The waste is packed into plastic bags and placed in front of the building at the road at the day of collection. The bags are collected manually by the loaders and thrown into the hopper of the collection truck	 Each house or building is equipped with their own bin or container. The bin or container usually is placed inside or directly in front of the premises and the house owner or the caretaker of a building takes care of their cleanliness, correct placement and that the correct waste types are placed. Usually the bin or container is placed at the kerb-side at the day of collection. The collection crew rolls the bins/containers to the collection truck and the bins/containers are load hydraulically	Typical for a street collection point system is the placement of containers along the street at a distance to buildings, which does not exceed 100m. The people have to carry their waste to the containers.  With this type the waste is collected by rolling the Euro-containers to the loading device of the collection truck and then the containers are emptied hydraulically into the truck.	 Given the immobile characteristics of this container type, it needs to be handled directly from the collection truck. Usually a side loading truck (see later) is being employed for hydraulic lifting and emptying.	Collection in stationary skip container  Suitable option for villages without paved roads.
Size available	Usually the bags have 50 or 80 l capacity	120 l, 240 l and 360 l are available in plastic and different colours, 110 l ring	1.1 m³ Euro containers are available in plastic and metal. However, usually for street	1.8m³, 2.4m³ and 3.6m³ are available in metal only	4.0m³ and 7.0m³ are available

	People frequently try to use plastic shopping bags to save the costs of the bags, if a standardized bag is not enforced.	bins are available in metal. 1.1 m³ Euro containers are available in plastic and metal.	collection, metal containers are applied, to prevent major damage when hot ash or other burning objects are deposited.		
Comfort for the user	High comfort related to collection: because the waste is directly collected from the individual house Low comfort related to space required on premises: because the bags need to be stored on the premises, until the next date of collection.	High comfort related to collection: because the waste is directly collected from the individual house Low comfort related to space required on premises: because the bins/containers usually are placed on the premises.	Medium comfort related to collection in blocks of flats areas: because waste needs to be carried to the container, which may be at a distance of up to 100 m from the door of the block. Bad comfort in family housing areas, given the long distances to bring the waste to the containers. High comfort related to space required on premises: because containers are placed on the street, i.e. outside any premises, having usually a high collection frequency.		Low comfort for user. Inconvenience for the residents as such skip containers are usually placed at the outskirts of the villages.
Requirements for collection truck	Rear end loading truck with low loading height.	Rear end, side or front loader, loading equipment for bins and/or containers	Rear end, side or front loader, loading equipment for Euro-containers.	Side loader truck suitable for this type of containers.	Require special truck for its loading Usually picked up with a skip truck (no compaction) Possible use of a large volume compaction trucks
Number of loaders required for loading on RCV	Minimum 2 persons If plastic shopping bags are accepted, 3 persons are required.	Minimum 2 persons, better 3 persons	Minimum 2 persons, if partially waste is place outside the containers better to have 3.	Minimum 1, in order to check the container. If waste is also placed outside the containers better to have 2 persons.	No loaders required
Preparation of storage/placement of bins/containers	No requirement	No requirement for bins, Euro containers require paved ground or slab	Containers require paved ground or slab	Flat ground, paved or graded ground is of advantage	Flat ground, paved or graded ground is of advantage
Loading efficiency	In dense areas, high loading efficiencies are possible. In family housing areas there is a low collection efficiency especially if collected daily	Bins: 2 bins can be loaded at the same time independently. Loading cycle about 50s per 2 bins, i.e. up to 720l. Usually the filling degree of	Loading cycle about 50-80 s per container. Allows good collection efficiency in family housing areas even if collected daily, if 20 to 30 houses are connected to the same container.	Loading cycle about 50-100 s per container, depending on size. Allows good collection efficiency in family housing areas even if collected daily, if 20 to 30 houses are connected to the	Loading of container usually takes up to 3 minutes. Low collection efficiency because the container is usually transported and emptied at the landfill (no waste compaction)

		bins is low if collected daily, because they are located in family housing areas. Containers: Loading cycle about 50-60s per container		same container.	
Costs of container	No costs for the collection system, bags to be procured by the waste producers.	Investment 36-60 €/bin; 120 €/plastic container (1100l) and 500 €/metal container (1100l) Costs to be borne by the collection system	Investment 150 €/plastic container (1,100 l) and 350 - 400 €/metal container (1100l). Costs to be borne by the collection system.	Investment 450 – 600 €/container Costs to be borne by the collection system.	Investment 1200 – 1800 €/container Costs to be borne by the collection system.
Suitability for quantity related tariffs	Suitable for volume related tariff to each household, if applied as prepaid bag system. In this case only prepaid bags will be collected. If not pre-paid bags are presented, it is almost impossible to identify the producer. Therefore from time to time any bags have to be collected in order to clean the area.	Suitable for volume related tariff related to houses or buildings/entrances;	Not suitable.	Not suitable.	Not suitable.
Foreseeable problems	If MW is place at the kerb-side more than 1 hour before collection, scavengers or cats and dogs might scavenge the bags and scatter the MW.	Caretaker in dispute with the tenants to correctly place the MW Potential issues in areas without paved roads and with difficult access for collection vehicle	Broken wheels and corroded bodies after some while, Cover often closed, Waste placed besides the container.	Corroded bodies after a while, Waste placed besides the container.	Corroded bodies Increased odour due to lower frequency of emptying such containers Increased tendency to be filled in with green, bulky and construction waste rather than household waste

Conclusion	Not recommended for future implementation	This system is applied, if a premise related tariff should be implemented. Recommended system for the areas with family houses.	Well-established system in the urban areas of project region . It will be further considered in the following chapters.	With this system the wheel-problem could be solved. If the waste would be placed properly in the containers, the system could even work with only one or even no loader. System requires higher investments for trucks and containers, than system 3A. It is therefore not recommended for the short term.	Not recommended for future implementation

Source of pictures: GIZ/MPLS, pictures expert team, MEVA Czech Republic, Scalventzi Itally, OTTO

The comparison of the different pre-collection systems comes to the following result:

- The pre-collection systems based on plastic bags (type 1), street collection points with fixed containers (type 3B) and skip containers (type 4) are not considered for future implementation.
- A bring system based on street collection points with 1.1 m^3 Euro-containers with wheels (type 3A) can be appropriate for the entire service area. Individual containers for blocks of flats, or even located at entrances of blocks of flats might have advantages compared with the street collection point systems from a tariff point of view. Such spaces are not available yet and would also reduce the collection efficiency, because such places probably would not always be alongside the road. Thus the provision of containers to individual blocks of flats or even located at entrances to blocks of flats is not recommended.
- In principle, a system with individual plastic bins (type 2) is appropriate for the areas with family houses and have been implemented in some urban areas in the project region. 120 l plastic containers will be preferred instead of 110 l metal-ring-bins in order to make possible that the bins can more easily be moved by the owners of the premises as well as the waste collection staff. However, the service provided with individual bins will have higher implementation costs because of the lower loading efficiency of the collection vehicles in comparison with the 1.1 m^3 containers. Additional limitations to implement individual bins will occur in the rural areas because of the difficult access and the bad condition of the local roads.

8.3.3 Container placement and container volume

In order to achieve the before mentioned advantage of collection points, there are some requirements, which need to be taken into account when designing the container number and placement:

- The containers should be placed in a number and location that they get filled on average to 80 to 90% at the time of empting (depending on the decided collection frequency);
- A radius of maximum 100 m is internationally recognised as a distance, which generally will be accepted by the people to transport their waste from the entrance of the buildings to the collection point. This means, that at large blocks of flats several containers will be placed at one collection point;
- The place for collection point should be chosen, that the collection truck easily could access the collection point without the need of major manoeuvring. This is best alongside the road;
- In order to allow easy handling and to save wear and tear on the wheels, the 1.1 m^3 container location should be paved (slab) and have a level connection to the road. This helps for easy rolling of the container to the rear of the collection truck and back to its placement. No manoeuvring of the truck should be required;
- The wheels have to be kept in good order and broken wheels need be replaced immediately. Broken wheels considerably reduce the speed of the collection and thus the collection efficiency.

8.3.4 Frequency of waste collection

More than 150,000 residents in the project area live in rural settlements. Only few of those have organised waste collection. This means that extending the waste collection service to entire rural area will necessitate considerable investments in waste collection equipment. Minimisation of investment cost is possible at higher frequency of servicing as a trade-off of investment and operational cost; i.e. the more often the containers are emptied, the fewer the number of containers are required, whereas larger number of containers are required if they are emptied less often.

In defining the frequency of collection the following assumptions are used:

- The frequency of collection in the villages for sanitary and odour purposes should not be less than once per week for 1.1 m^3 containers and once per two weeks for 120 l bins. Waste collection frequency in villages could be adjusted to the respective seasons - higher frequency in summer months and lower frequency in the winter months;
- In urban areas, collection frequency could not be lower than once per week.

8.3.5 Waste collection vehicles

Currently 21 waste collection vehicles and 9 tractors are used in WMZ 8. The majority of the collection vehicles are older than 10 years and need to be replaced.
Some of the available trucks are based on Russian and Belarussian chassis. In most cases the superstructures have a capacity of 4-7 m^3. These vehicles have certain advantages: lower price compared to Western trucks; easy maintenance and repair; and suitability for unpaved roads due to the high structure of their chassis. Their main disadvantage is the low compaction rate.
On the contrary, Western waste collection vehicles produce higher efficiency through higher compaction rate. Besides their higher operational efficiency, their higher acquisition price will be compensated by the lesser number of vehicles needed based on larger volumes of waste collected per run.
Therefore, the analysis of options for enhanced waste collection envisages two types of waste collection vehicles:

- Large 16 m^3 waste collection vehicles for servicing the large metal 1.1 m^3 containers and for servicing part of the rural areas. Based on the existing road network it is assumed that vehicles larger than this (e.g. 18 m^3 or 22 m^3) will be too heavy and not appropriate;
- Small 10 m^3 waste collection vehicles suitable for door-to-door collection in urban areas and for some villages with difficult road access.

8.3.6 Options for collection and transport of residual waste

On the basis of all considerations above, the following two options have been analysed and cost detailed with regard to their applicability to local conditions and desirability to extend the waste collection service to the entire area:

- Option 1: waste collection is organised in the entire WMZ 8 by the so-called “bring system”, meaning through use of containers of 1.1 m^3 containers intended to serve large number of households;
- Option 2: individual houses in the towns of Donduseni, Briceni, Edinet and Ocnita are served by “door-to-door” collection (with 120 l plastic bins assigned to individual households), while the rest settlements are served by “bring system”.

A “door-to-door” collection system with individual plastic bins is not considered as an applicable short-term option in villages because of the difficult road access to a significant number of households. This approach shall be re-evaluated in the future (e.g. at the time of first container replacement).

The projections for the necessary number of containers and collection vehicles and the costs estimates for the municipal waste collection and provided in the following table.

Table 8-6: Waste collection equipment needed

Type of waste collection equipment	№ of waste collection equipment	
	Option 1	Option 2
Containers needed, 1.1m^3	4,237	4,595
Containers needed, 120 l	8,947	-
Vehicles needed, 16 m^3	7	9
Vehicles needed, 10 m^3	8	4

Source: GIZ/MLPS

8.3.7 Cost comparison of the options for collection of residual waste

The calculations of collection costs are performed separately for the urban areas and for the rural areas in each individual rayon, taking into account the different types of containers and collection vehicles used.
Investment and operating costs for the future municipal waste collection system are calculated separately for each rayon taking into account the respective distances to the regional landfill site.
The following assumptions were done for the calculation of waste collection costs:

- The numbers and capacities of necessary collection containers and vehicles correspond to the quantities of waste collected, calculated through the number of residents served and the respective per capita waste generation rates in urban and rural areas for the respective year. The amount of separately collected waste is taken into account;
- Waste density in containers 180 kg/m^3;

- 80% average degree of container filling;
- Irregularity coefficient representing the ratio between the maxim and the average weekly waste quantity is equal to 1.3;
- Travelling speed of RCV is accepted at 35 km/hour;
- 85% utilization of nominal collection vehicle payload;
- 90% availability of collection vehicle;
- Reserve containers for maintenance – 5%;
- Time for lifting of 1.1 m^3 container is 1,0 minute on average in blocks of flats containers (incl. time for travelling to the next container). The time for lifting of 1 container in the family houses areas is assumed to be 1.5 minutes. Time for lifting of waste bins is estimated to 0,42 minutes (25 seconds);
- The average travelling distances between the landfill site and individual cities/rayons are measured towards the respective city centre;
- Average time spent for unloading at the disposal site will be half hour; The buffer time between the trips will also be half hour;
- Two types of RCVs will be used:
- 16 m^3 RCV with payload of 8 tonnes of waste per vehicle (corresponds to 500 kg/m^3 compacted waste);
- 10 m^3 with payload of 5 tonnes of waste per vehicle;
- The lifetime for containers and bins is accepted 7 years and 10 years for RCVs;
- The existing containers are taken into account and the respective replacement costs are included assuming same lifetime like for new equipment;
- The annual maintenance costs are accepted to be 4% of the investment costs for the containers and 5% for the vehicles;
- Costs for the administration of the system 10% of direct operating costs;
- Insurance for collection vehicles and personnel – 1% of investment costs;
- Out of schedule services – 5% of operating costs plus annual depreciation
- The labour costs are calculated for 46 working weeks per person, 5 working days per week and 5% sick leave on average.

The following table presents the unit costs for residual waste collection assumed for the options analysis.

Table 8-7: Unit cost of waste collection equipment

Equipment	Capacity, m^3	Purpose	Unit price, EUR
Container	1.1	Bring system collection	320
Bin	0.12	Door-to-door collection	30
Truck	16	Bring system collection	130,000
Truck	10	Door-to-door collection Bring system collection rural areas	92,000

Source: GIZ/MLPS

The investment and operating costs for the collection of mixed municipal waste are presented in the following tables.

Table 8-8: Cost comparison of options for collection and transport of residual waste

Costs	Costs in EUR	
	Option 1	**Option 2**
Investment cost	**3,276,000**	**3,014,000**
Containers 1.1 m^3	1,356,000	1,470,000
Bins 120 l	268,000	-
Vehicles 16 m^3	910,000	1,170,000
Vehicles 10 m^3	736,000	368,000
Vehicles for supervisors	60,000	60,000
O&M costs	**598,000**	**554,000**
Total annual costs	1,008,000	932,000
Quantities collected, tonne	33,363	33,363
Annual unit cost, EUR/tonne collected	**30.21**	**27.93**
Average Incremental Costs, EUR/tonne generated	**27.37**	**25.18**

Source: GIZ/MLPS

The operational and maintenance costs (O&M) include costs for personnel, fuel, oil and maintenance costs for equipment. The annual costs include O&M costs and costs for annual depreciation of containers and vehicles.

8.3.8 Conclusion

As seen from the table above, both options have comparable implementation costs and Options 1 is a little more expensive in comparison with Option 2, due to the higher service costs for the individual bins.
Considering that individual bins are already provided to some of the family houses in urban areas, and changes in the provided services will not be supported by residents, Option 2 will be recommended for further implementation.
It should be noted however that once the waste collection system is established in the project area and cost recovery mechanisms are in place, the future upgrade of the system should again reconsider the implementation of door-to-door collection system in rural areas as the most customer-friendly one. This is based on the fact that the population in WMZ 8 live predominantly in individual houses.

8.4 Technical options for transfer of municipal waste

Transfer stations are justified when the cost to transport waste directly from the point of generation to a disposal site is greater than the cost to transport the waste from the source of generation to a point where the waste is transferred onto a larger container and then

transported to a landfill. Economical expediency of transfer stations is influenced by several factors:

- Distances;
- Quantities of waste (capacity of transfer station);
- Road conditions and topography;
- Low density of population in the service areas; and
- Technology of transfer.

8.4.1 Transfer station types

Transfer stations can be basically divided into two types:

- Transfer of MW by using a compaction system;
- Transfer of MW using containers or semi trailers without compaction.

The transfer stations can be constructed:

- As stations with direct unloading into the transfer hopper or containers, or
- With an interim storage area, which allows buffering the waste in peak hours.

The transfer stations may be:

- Open air plants, if the transfer site is far outside populated areas and odour problems are of no concern,
- The transfer area might be covered with a roof, in order to allow proper working conditions in case of rain, or
- The transfer area might be fully housed and will include ventilation and odour treatment. This third option usually is used for transfer stations, built in densely populated areas.

Often these transfer stations are combined with public amenity sites including:

- Green waste collection, interim storage and shredding places,
- Acceptance points for recycling materials or
- Domestic hazardous waste acceptance points.

Transfer stations without compaction are used when distances are not large and then the higher investment costs of transfer stations with compaction cannot be justified.

With larger distances the operational costs of transfer stations without compaction become higher compared to those of transfer stations with compaction. The choice of transfer station is in fact a trade off of investment and operational cost.

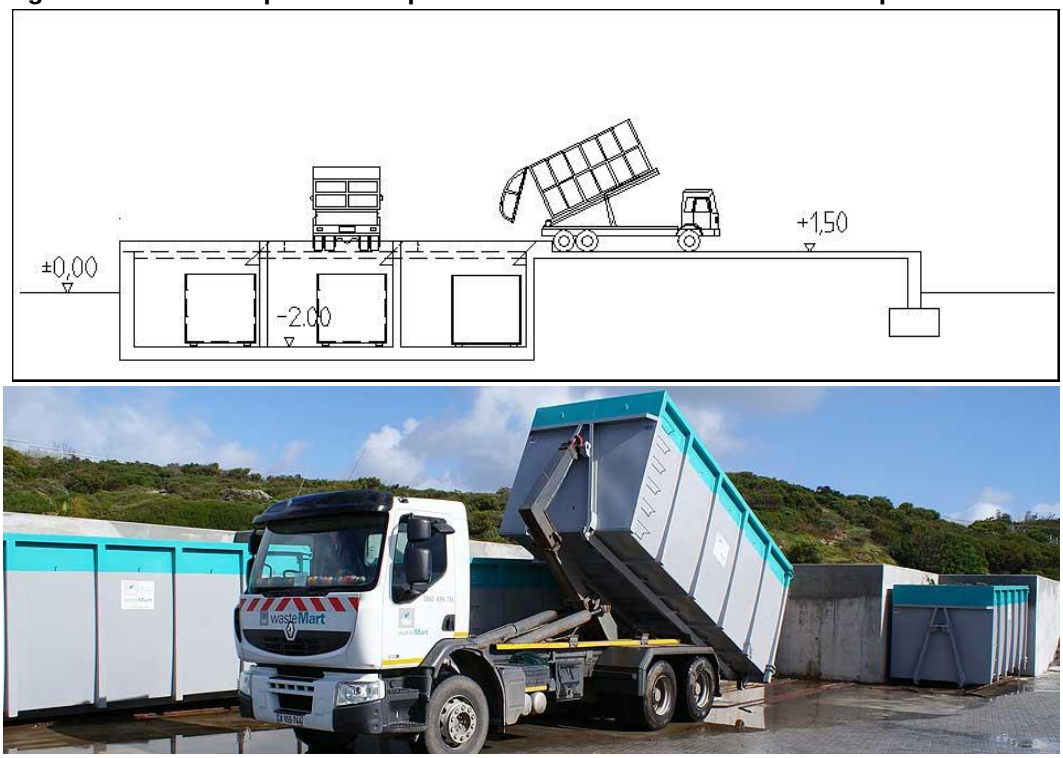
The capacity of a transfer station has an impact on the unit costs of transfer. As for most of plants, the economy of scales is also an important issue for the transfer station.

The location of the transfer station should be as close as possible to its catchment area, in order to allow for short distances for the RCVs to deliver their MW. The shorter the distance to the transfer station, the more time is left for the truck for another trip, or if not fully loaded for longer collection.

Transfer stations without compaction

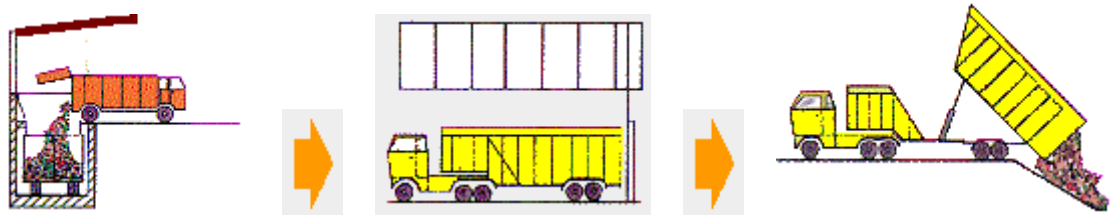
For municipal waste quantities of up to 150,000 t/a (400 t/day), simple transfer stations with open containers are the more economic solution. As figures below show, the waste is directly tipped into a container or semi-trailer and then is shipped to the treatment or disposal plant. There are several types of semi-trailer technologies, such as tippers, as shown below or semi-trailers with walking floor. Such a transfer station usually has several tipping places into several containers or semi-trailers.

Figure 8-2: Example for an open transfer station with transfer in open containers



Source: GIZ/MLPS, WasteMart

Figure 8-3: Example for transfer in open semi-trailer and transport



Transfer **Transfer-vehicle 70 m³** **Disposal at landfill**

Source: GIZ/MLPS, Transfer Station Swistal-Miel, Germany

Often the municipal waste is slightly compacted by a wheeled loader or rolling compactor before shipping. Depending on whether the waste already was compacted in a waste collection vehicle or whether it was delivered loose on open trucks or by companies, the density in these containers can vary between 200 kg/m³ and 350 kg/m³.

The municipal is then transported by truck-trailers, transporting 2 containers of 40 m³ each, or about 16 to 20 t in total or walking floor semi-trailers with 100 m³, transporting 18 to 22 t, depending on the MW.

Transfer stations with compaction

The purpose of transfer stations with compaction is to increase the density of the waste and thus the quantities of waste to be transported in one run. As shown in the figure below, such transfer stations are equipped with a ramp with discharging point, reception bunker (of about 45 m^3), compacting device, large transportable containers (between 27 m^3 and 32 m^3), railing system for shifting the containers, and vehicles for long distance transportation.

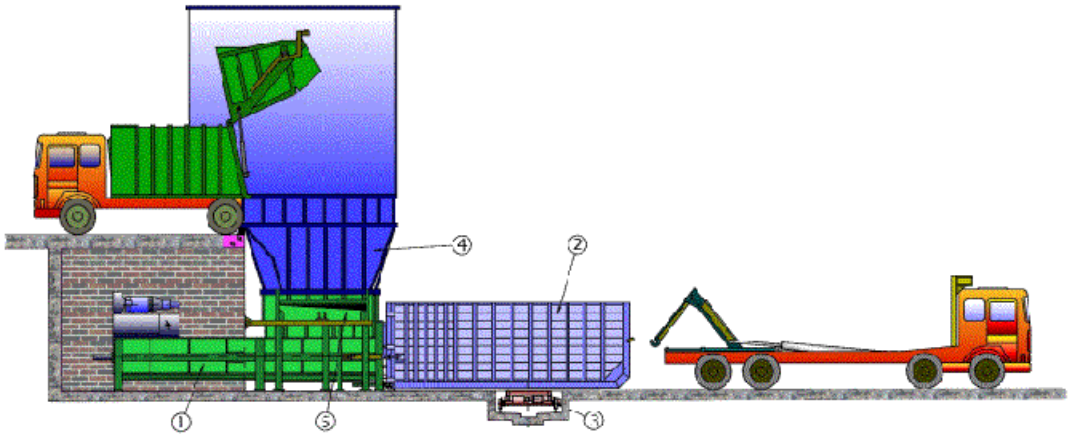
Equipment of such transfer stations is designed to minimize the loading time from collecting trucks and to minimize the compacting time for the waste. An automatic railing system for shifting the containers is installed also to reduce the operation time. While a long distance transport vehicle is being loaded with a full container, another container may receive new wastes.

In a compaction transfer station, the MW is compacted to a density of up to 600 kg/m³. There are compaction systems which can compact up to 70 t/h of waste, mainly limited by the necessary exchange of compaction containers. Such compaction containers might also be mounted on semi-trailers.

In order to always be sure that at least one compactor is operating, even in periods of major overhauls of a compactor, usually a transfer station needs to be equipped with at least 2 compactors. Besides the much more complicated mechanical equipment from compacting, the need of at least 2 compactors results in comparatively high costs when small waste quantities are being transferred. Additionally for small quantities, 2 compactors cause high over-capacities.

The static compacting device can be substituted with large self-compacting transportable containers, between 25 and 32 m^3, able to store between 15 and 19 tonnes.

Figure 8-4: Transfer station with compaction



Source: GIZ/MLPS

The transfer stations with compaction are usually used for large quantities and long transfer distances. However, given, that due to maximum weight conditions on road of 40 t, the maximum payload usually is in the range of 22 to 24 t, i.e. practically the same weight as used for transfer without compaction (see section before).

Table 8-9: Comparison of the technical options for transfer station

Item	Waste transfer without compaction	Waste transfer with compaction
Invest for transfer station	Lower	Higher (additional costs for hydraulic compaction system)
Invest for waste transfer	Higher (additional waste transfer trucks and waste containers)	Lower
Operation and maintenance for transfer station	Lower	Higher (energy consumption for compaction)
Operation and maintenance for waste transfer	Higher (energy consumption for waste transport)	Lower
Density of transported waste	250 to 350 kg/m³, since waste from compaction RCV is pre-compacted	Up to 600 kg/m³
Average load transported on transfer vehicles (road transport)	- up to 22 t/vehicle	- up to 22 t/vehicle
Construction	Easy construction; at very small quantities tipping on the floor and loading by loader,	More complicated construction due to compaction equipment.

Item	Waste transfer without compaction	Waste transfer with compaction
	at higher quantities tipping over an elevation directly into the containers.	
Odour emissions	Odour emissions during transfer, if station is not housed and little during transport.	Odour emissions during transfer, if station is not housed. No emissions during transport.
Storage of containers overnight	Overnight storage of containers possible, if containers are covered.	Overnight storage possible, because containers are densely closed.
Flexibility at increasing quantities	The transfer station design can easily be adjusted to the quantities from time to time, by adding additional tipping places.	Inflexible, since at least two compactors should be installed, each compactor having a capacity of about 70 t/h. i.e. at smaller quantities the plant runs with overcapacity.
Break down problems	No problems with break down	If complete plant breaks down, e.g. because of electricity break down, no transfer possible. Usually minimum one compactor is operating in order to process the waste.
Buffering waste	Possible at both types, depends on design	
Connection with other waste management activities	Possible at both types for recycling banks, hazardous waste acceptance points and green waste collection points.	
Recommendation	Recommended, if transfer stations will be required for the service areas	Not recommended, because there are no advantages against the transfer without compaction.

Source: GIZ/MLPS

As seen from the table above, both options have their advantages and disadvantages.
For the purposes of the current analysis transfer stations with and without stationary compaction press are considered. The main reason for transfer station without compaction is the fact that the predominant population in the WMZ 8 is rural (70%) and the waste composition in the rural areas indicates that the main fraction of household waste generated is inert (earth, stones, ash etc.). Inert waste is not subject to compression and use of more expensive equipment, like compaction press, is not justified.
A transfer station without compaction will also allow transfer of recyclable waste and green waste because of multiple discharge points.

8.4.2 Options for transfer stations

For the purpose of option analysis the possible construction of three transfer stations – in Briceni, Edinet and Ocnita rayons was considered.
The waste collected in Donduseni rayon will be transported directly to the new regional landfill.
The proposed sites for the construction of transfer stations will be located at Briceni, Edinet and at the existing landfill in Ocnita. The waste quantities transferred and the transport

distances between the potential sites for the transfer stations and the new regional landfill are presented in the following table.

Table 8-10: Criteria for establishment of potential transfer stations in WMZ 8 (2021)

Criterion	Unit	TS in Briceni	TS in Edinet	TS in Ocnita
Population covered	No.	64,933	66,546	43,628
Waste transferred	tonne	11,625	11,684	8,124
Distance to the landfill	km	74.9	43.4	41.3

Source: GIZ/MLPS

For each of the sites three possible alternatives were identified:

- transfer station with stationary compactor and transportation of waste with hook-lift truck in closed 28 m^3 containers;
- transfer station without compaction and transportation of waste in open roll-on containers
- transfer station without compaction and transportation of waste in open roll-on containers with additional trailer

The tables below present the expected investment and operational costs for the different alternatives.

Table 8-11: Summary investment and operating costs of the transfer stations

Description of works and equipment	Briceni Rayon			Edinet Rayon			Ocnita Rayon		
Transfer station type									
Compaction	yes	no	no	yes	no	no	yes	no	no
Trailer	no	no	yes	no	no	yes	no	no	yes
Investment costs									
Ground	0	0	0	0	0	0	0	0	0
Civil works	273,595	257,595	257,595	272,595	257,595	257,595	268,495	257,595	257,595
Machinery	155,540	0,500	0,500	155,540	0,500	0,500	155,540	0,500	0,500
Vehicles	272,000	288,000	208,000	162,000	288,000	208,000	149,000	278,000	198,000
Engineering, commissioning, contingencies	56,568	32,637	32,637	56,568	32,637	32,637	54,858	31,637	31,637
Total Investment costs	**756,704**	**578,732**	**498,732**	**646,704**	**578,732**	**498,732**	**627,894**	**567,732**	**487,732**
Annual	**118,107**	**149,739**	**94,630**	**82,195**	**114,531**	**76,236**	**82,161**	**108,965**	**76,147**

Description of works and equipment	Briceni Rayon			Edinet Rayon			Ocnita Rayon		
operating costs (2021)									
Average Incremental Costs (€/tonne)	**16.28**	**18.00**	**12.41**	**11.61**	**13.42**	**9.74**	**17.74**	**20.01**	**14.90**

Source: GIZ/MLPS

As seen from the table above, the establishment of transfer station without compaction and transportation of waste with a hook-lift truck with additional trailer is the most cost effective solution for both rayons.

8.4.3 Conclusions

The final decision for the construction of transfer station requires the total costs for waste collection and transfer to be compared with the costs for the direct transportation of waste to regional landfill.
For that purpose the unit costs per tonne of waste generated were calculated separately for the different alternatives and presented in the following table.

Table 8-12: Comparison of direct transport with waste transfer based on unit cost per tonne (€/tonne)

Description	Briceni		Edinet		Ocnita	
	direct transport	**with transfer**	**direct transport**	**with transfer**	**direct transport**	**with transfer**
Residual collection						
Investment costs	17.26	12.81	15.75	10.84	15.00	11.64
Operating costs	30.65	16.34	24.82	12.94	25.23	15.36
Total residual collection costs	*47.91*	*29.15*	*40.57*	*23.78*	*40.22*	*27.00*
Transfer of residual waste						
Investment costs	-	4.22	-	3.80		5.69
Operating costs	-	8.19	-	5.94		9.21
Total waste transfer costs	-	*12.41*	-	*9.74*		*14.90*
Total waste collection and transfer						
Investment costs	17.26	17.02	15.75	14.64	15.00	17.33
Operating costs	30.65	24.54	24.82	18.88	25.23	24.58
Total waste collection and transfer	***47.91***	***41.56***	***40.57***	***33.52***	***40.22***	***41.91***

Source: GIZ/MLPS

As seen from the table above, the construction of transfer station is justified for the Briceni and Edinet rayons because of the lower total implementation costs in comparison to direct transport of waste.

In Briceni rayon the unit costs for collection and transfer are estimated to 41.56 €/tonne while the direct transport of waste will require 47.91 €/tonne. The unit costs for Edinet rayon are estimated to 33.52 €/tonne in case of waste transfer and 40.57 €/tonne for the direct transport.
For Ocnita rayon the direct transport will have a little lower costs per tonne and the establishment of a transfer station cannot be justified.

8.5 Technical options for sorting of municipal waste

Sorting of municipal waste could be implemented in basically two ways:

- Separation of recyclables at the sorting station from the collected mixed municipal waste, i.e. the whole municipal waste stream is subject to sorting;
- Separation of recyclables at the sorting station from the separately collected waste streams, i.e. collected residual waste is not subject to further separation.

The table below presents advantages and disadvantages of these two alternatives.

Table 8-13: Advantages and disadvantages of the alternatives for sorting of municipal waste

Description of works and equipment	Advantages	Disadvantages
Sorting facilities for mixed solid waste	• Does not require additional collection cost and change of practice; • Flexibility in sorting greater number of materials depending on market potential; • Flexibility to potentially adapt it to MBT technology.	• Recyclables are contaminated, of less value, paper and cardboard could hardly be recycled; • Higher investment costs; • Limited in terms of resource recovery (between 5 and 10% of total waste quantities); • It does not lead to development of recycling system and does not change consumer behaviour.
Sorting station for separately collected recyclables	• Lower investment costs; • Cleaner recyclables with higher market value; • Provides for further development of the recycling system and increase of public involvement.	• Lower implementation costs; but combined with higher collection efforts lead to similar overall costs; • It requires change of attitude and practice of residents; • It necessitate continuous efforts for public involvement and costs for public awareness raising.

Source: GIZ/MLPS

As it can be seen, both practices have advantages which depend on the type of the overall waste management system and mainly on the type of (separate) waste collection system.
It shall be noted that from the EU legislation point of view the sorting of residual waste shall not be considered as an alternative to the separation at source and shall be considered as an additional measure for pre-treatment of waste prior landfilling.

As designated, the sorting of separately collected recyclables can be carried out in two different ways, called positive or negative sorting. Negative sorting means that impurities located within the recyclables are sorted out, while positive sorting gathers the recyclables themselves. The advantage of the positive sorting is the higher degree of output quality and the possibility to create not just one output product (e.g. cardboard and paper can be created). It is assumed that the captured amount of recyclables is 85%, no matter what type of sorting.

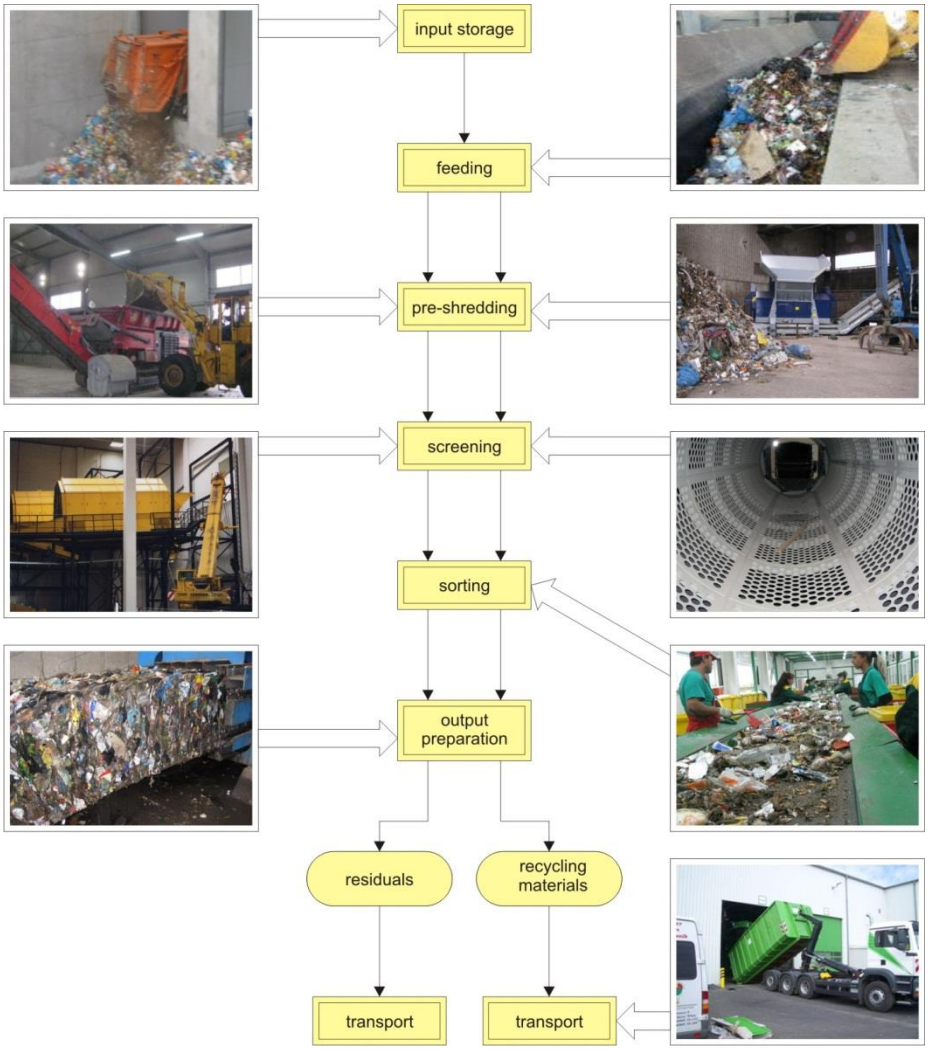
8.5.1 General overview of the sorting process

The process engineering of a solid waste treatment plant consists of some main processing components that exist in all treatment plants (Figure 8-5). The challenge is to design these processing steps and machines consistent with the basic conditions given, e.g.:

- type of waste;
- quantity of waste;
- quality requirements of output fractions;
- financial resources;
- basic conditions for logistics.

As a result, the best version from the possible design types has to be chosen.

Figure 8-5: Waste sorting process



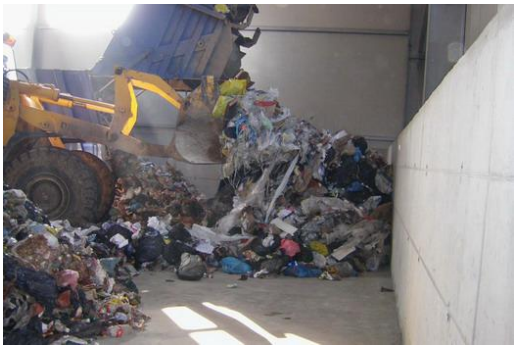
Source: GIZ/MLPS

Delivery and unloading

The unloading of the delivery vehicles can be executed in two ways. Either the collection vehicle unloads the waste into the storage area from above (variant 1), while staying outside of the input hall, or it drives into the hall (variant 2).

From above the input storage (V1)

Inside the input hall (V2)



Source: GIZ/MLPS

Variant 1 requires a larger construction effort because delivery and storage are situated on different ground levels. Therefore, either a ramp has to bring the collection vehicles to a higher position or the bunker has to be located on a deeper level. This is advantageous in that the logistics of delivery and feeding are separated; hence, there is a larger capacity for the number of collection vehicles and unloading is not interrupted. Variant 1 is preferred if the number of vehicles reaches a certain point. Furthermore, less space is needed inside the input hall because the collection vehicles stay outside.

Feeding

Within the input storage area, either a wheel loader or a mobile excavator is used to feed the following processing line. The use of a mobile excavator does not replace a wheel loader, as the arrangement of delivered waste can only be fulfilled by a wheel loader.

Wheel loader

Mobile excavator

Source: GIZ/MLPS expert team

Whereas the wheel loader with a shovel volume of 3 to 5 m³ has a larger feeding capacity, the gripper system (approx. 1.5 m³) allows the driver to separate coarse impurities. Pre-sorting is not possible with a wheel loader, but it is capable of piling up the delivered and stored waste.
If the direct feeding of a shredder is intended, the use of a wheel loader has the disadvantage of impairing the view into the hopper. Coarse impurities could get into the shredder without being noticed. In contrast, the mobile excavator – with its high situated cab – is conducive to recognizing the fill level of the shredder.
Considering the overall logistics at the plant, a wheel loader is better utilized for material transport at other places (e.g. output storage and output collection). Nevertheless, it is recommendable to use a mobile excavator as it is advantageous to protect the shredder from impurities.

To feed the processing line with the delivered waste, a storage belt above the ground or underfloor can be used.

Storage belt (above the ground)

Storage belt (underfloor)

Source: GIZ/MLPS

The simple solution is the one above the ground because the dosing of the input to the following machines can be done more evenly, thus causing less technical problems. Furthermore, the accessibility of the storage belt above the ground guarantees that repairs and cleaning can be carried out more easily than with the belt embedded in the ground. Concerning the underground storage belt, pieces of waste can fall down and hook between the belt and the housing.

With regard to the underfloor variant, the handling of the feeding is uncomplicated: a wheel loader just pushes the waste into the hopper. The only disadvantage is the abrasion of the concrete caused by the wheel loader pushing the waste into the hopper. However, the wheel loader has more time to handle other tasks.

What has to be taken into consideration is the available space. In the case of the underfloor variant, the next conveyor belt has to be extended longer in order to reach the necessary height to the following machine (usually a sieving machine). Furthermore, the construction costs exceed the ones of the storage belt above the ground.

Pre-shredding

Using a shredder for the treatment of household waste is debatable. On the one hand pre-shredding opens the delivered waste bags, on the other hand it has a large impact on the waste's characteristics as it changes the distribution of the grain size towards finer material.
As far as screening followed by manual sorting is intended, the sorting staff will pick out less recyclables because of two reasons. The material flow going into manual sorting decreases as a consequence of pre-shredding (the fine fraction is not sorted) and the manual sorting of smaller pieces is not efficient.
Concerning the collection of recyclables, pre-shredding of household waste is rather disadvantageous. Tearing the waste bags can be carried out by components installed in the screen drum.
Furthermore, refraining from pre-shredding simplifies manual glass collection (preservation of entire glass bottles) and means lower investment and operational costs.

Pre-shredding

Without pre-shredding

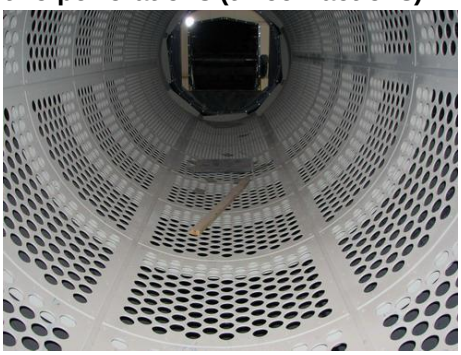
Source: GIZ/MLPS

Aside from the statements made, pre-shredding is advantageous for the treatment of bulky waste. In this case, it prevents damage of the following machines as larger materials could block them.

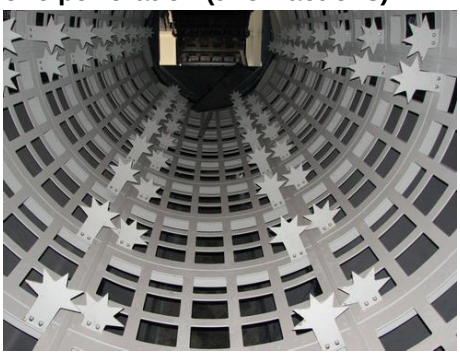
Screen fractions

No matter what kind of sieving machine is used (e.g. screen drum, vibration screen) it can be designed with one or more different hole diameters. In general, either a screen with one perforation or with two perforations is used.

two perforations (three fractions)



one perforation (two fractions)



Source: GIZ/MLPS

The efficiency of a screen with one perforation is higher, i.e. less fine fraction material is discharged with the overflow. This means that if the overflow is intended to be RDF material a better quality is produced.
On the other hand, a processing line design with three fractions means a requirement for two sieves in a row if sieves with only one perforation are used. In that case, this results in higher investment costs and space requirements.
The implementation of one sieve with two perforations represents an advantageous alternative; however, the quality of the output fractions decreases.

Sorting (manual/automatic)

One main aspect concerning whether to apply a manual sorting line or an automatic sorting system is the interaction between investment and operational costs. The installation of a manual separation system is limited to a sorting cabin with exhaust air treatment and a

capture system for the separated fractions. Automatic sorting systems like near-infrared technique (NIR) require complex equipment (sensor technology, compressor unit), however only work with low material height and limited particle size on the conveyor belt.

Manual separation

Automatic sorting systems

Source: GIZ/MLPS

Manual sorting results in an increased sorting capacity, yet the quality of the gathered materials is reduced. In contrast, the automatic system is able to distinguish between different types of plastic (e.g. PET, PE, PS, PVC), paper, wood, etc. As such, higher revenues can be achieved.

Gathering of manual sorted materials

As seen in the pictures, the sorting cabin is located at a higher level; therefore, the sorted material can fall to the ground level into separate sections. Subsequently, there are two ways of gathering the fractions: automatically or manually.

Storage conveyor belt

Boxes

Source: GIZ/MLPS

Regarding the automatic system, a storage conveyor belt for every collected fraction located beneath the sorting cabin, moves the fraction onto the main underfloor belt that leads to a baling press, for example. Using this system means higher investment but lower operation costs.

The advantage of the box system is its simplicity. They provide the opportunity to either empty them by a wheel loader or to collect the separated fractions directly in a container located beneath the sorting cabin. If a wheel loader is used to push the materials onto an underfloor belt, there is a necessity for wider boxes and thus a larger sorting area above.

Output preparation

What kind of preparation level the output fractions have to achieve depends on the purchase agreements with the customers and possible steps of preparation in further preparation plants. This applies to RDF as well as other recycled materials.

Loose transport of RDF

Pressed to bales (RDF)

Source: GIZ/MLPS

With regard to the investment costs, the cheapest method is to load the material in a loose shape. Considering RDF, a loose shape makes it easier to take samples and examine the calorific value and chlorine content later on. On the other hand, low density increases transportation costs. Nevertheless, for RDF it is the common way of transport.

For more efficient transport, RDF can be pressed into bales as usual for the sorted recyclables. In consequence, the energy density is higher. Pressing into bales induces additional investigations and costs for the wire and the wear of the baling press.

Improving RDF quality

One possible objective of the RDF preparation is its combustion in co-incineration processes, like in cement plants. Therefore, constant calorific values and combustion characteristics have to be fulfilled. Depending on the method of incineration, the sorting residuals intended to be RDF pass either through a granulator or a pan grinder mill.

Granulator and granulate

Pan grinder mill and pellets

Source: GIZ/MLPS

Both ways are linked with high investment and operational costs (high wear of machines). But granulated RDF can achieve better revenues and often is a prerequisite for marketing.

Because of the compaction, the pellets have a higher specific energy value and a higher bulk density. Therefore, the transportation costs are lower.

Vehicles collecting the output

The two ways of collecting and taking away output material common in Germany can be seen in the pictures below. Whereas containers can be used for all kinds of material, walking floor vehicles only transport light RDF-material. Reason is the maximum permissible vehicle load capacity that would be exceeded by heavier materials.

Container transport

Walking floor vehicles

Source: GIZ/MLPS

Implementing a container based transport system provides diverse opportunities. No matter what kinds of materials have to be dealt with (RDF, plastic, wood, metals, residues, etc.), it enables unified logistics based on the same containers and trucks. In general, containers with a volume of 40 m³ are used.

The walking floor vehicles achieve lower specific transport costs because of the higher container volume (up to 90 m³). With their moving floor inside of the trailer, they can unload without being elevated. However, this only allows for transporting fine/light materials like RDF.

8.5.2 Identification of options for sorting of waste

The total amount of separately collected materials in the region is estimated to grow from 3,800 tonnes in 2021 to 6,800 tonnes in 2040. These quantities are relatively low and presume the establishment of a centralized sorting facility for the entire WM zone. Nevertheless, taking into account that the landfill in Ocnita will be in operation till 2030 the construction of additional small sorting site serving the needs of Ocnita rayon have been considered in the option analysis.
The possible technical options for sorting of municipal waste shall be based both on the possible options for collection of residual waste and on options for separate waste collection.
Taking into consideration the analysis of the above two waste management elements, three options for sorting of municipal waste are identified:

- Option 1: Sorting of separately collected waste from all four rayons at one centralised sorting station. The centralized sorting station is proposed to be situared at the transfer station in Edinet because rayon generates the largest quantities of recyclables in the project area and the central location. Alternative location is at the regional landfill;
- Option 2: Sorting of residual municipal waste with separation of recyclables at centralised sorting facility situated at the regional landfill. Sorting of separately collected waste at the same facility;
- Option 3: Sorting of residual municipal waste with separation of recyclables and RDF at centralised sorting facility in addition to sorting of separately collected waste (extension of Option 2).

In all options considered the separate collection of recyclables is based on the recommended Option 1.

The three sorting options are described in more details in the section below.

8.5.3 Description of the sorting options

Option 1
Option 3 is based on the recommended alternative for collection of recyclables (Option 1), which envisages the following:

- Separate waste collection is organised in the entire urban area of WMZ 8. The “bring system”, is organised by 3 containers of 1.1 m^3; one for paper and cardboard, one for plastic and metal and one for glass.

- The separately collected materials from all rayons will be delivered to a centralized sorting facility located at the site of Edinet transfer station. The facility will have a capacity of 4,000 tonnes/year with one sorting line comprised of manual picking station, horizontal baling press and the necessary feeding lines and conveyor belts. Considering the relatively small capacity of the installation no special equipment for glass treatment is envisaged on site.

Option 2

Option 2 envisages sorting of all residual waste collected from entire WMZ 8. The collected mixed waste will be transported to the sorting facility with the aim of extraction of those recyclable fractions that have market value. The location of the sorting facility shall be at the site of future landfill near Donduseni.

The process of waste sorting includes the following main steps:

- Visual control and manual separation of bulky and hazardous waste at the entry of the sorting facility.
- **Feeding of processing line**. The loader transports the solid waste to the feeding bunker with devices for dosing the material flow for opening refuse bags. In this way the waste flow can be managed through the process;
- **Sifting out of fine fraction**. The sifting is performed in rotary sieve with size of holes 60-80mm. The fine fraction is of organic or inert character and is diverted for disposal;
- **Separation of recyclables**. Separation of recyclables after the rotary sieve includes magnetic separation of ferrous materials, manual separation of paper, cardboard, plastic and glass in a sorting cabin. The residual waste is transported for disposal to the landfill.

Further processing typically includes baling for paper, steel cans, and plastic bottles, flattening or compacting for aluminium cans; granulating or perforating for plastic bottles; and crushing for glass bottles. The separated materials are then sold to the identified buyers.

Safety issues for the equipment operators and sorting workers include protection for the operation of power equipment, as well as eye, ear, respiratory and dermal protection.

The facility needs to operate the same number of working days as the general waste collection system.

The following assumptions are made regarding the facility performance and operations:

- Rate of recycling: 25% of plastics and glass; 12% of paper and cardboard, and 35% of metals are assumed to be separated;
- In total, about 5% of waste is expected to be segregated as valuable recyclables.

As a result of the sorting process, about 3,000 tonnes of recyclable materials could be expected.

The facility will also receive the separately collected waste from the entire WMZ 8 and for that purpose separate feeding line, following the rotary separator will be envisaged.

Option 3

Option 3 is based on the extension of Option 2 with additional separation of RDF. For that purpose additional equipment like air classifier, shredder, eddy current separator and storage areas for RDF produced will be envisaged.

The table below presents the main assumptions and parameters of the four identified options.

Table 8-14: Assumptions and parameters of the four sorting options, 2021

Indicators	Unit	Option 1	Option 2	Option 3
Capacity of sorting line	tonne	4,000	36,000	36,000
Manual sorters	№	11	17	17
Additional staff	№	5	9	11
Separately collected waste (SCW)				
Plastic extracted	tonne	742	742	742
Paper and cardboard extracted	tonne	1,139	1,139	1,139
Glass extracted	tonne	789	789	789
Metal extracted	tonne	413	413	413
Total recyclables extracted (SCW)	tonne	3,082	3,082	3,082
Residual waste (RW)				
Plastic extracted	tonne	-	1,162	1,162
Paper and cardboard extracted	tonne	-	646	646
Glass extracted	tonne	-	593	593
Metal extracted	tonne	-	355	355
Total recyclables extracted (RW)	tonne	-	2,757	2,757
Total recyclables extracted	tonne	3,082	5,839	5,839
RDF produced	tonne	-	-	2,232
Recovered from total waste	%	7.68%	14.56%	20.12%

Source: GIZ/MLPS

8.5.4 Cost assessment of the options for sorting of waste

The table below presents the costs associated with the implementation of each of the four options for sorting of waste (2021 as base year).

Table 8-15: Cost comparison of the sorting options, 2021

Costs	Costs in EUR		
	Option 1	Option 2	Option 3
Investment costs	847,000	2,779,000	3,854,000
Buildings and works	506,000	942,000	1,093,000
Sorting equipment	234,000	1,336,000	2,289,000
Mobile equipment	70,000	414,000	414,000
Other	37,000	57,000	58,000

Costs	Costs in EUR		
	Option 1	Option 2	Option 3
O&M costs	**128,000**	**600,000**	**785,000**
Annual costs	173,000	772,000	1,023,000

Source: GIZ/MLPS

The table below present the average current market prices of recyclables.

Table 8-16: Prices of recyclables, EUR/tonne (ex-works sorting plant)

Recyclable material	Separately collected waste, €/tonne	Residual waste, €/tonne
Plastic	220	120
Paper & cardboard	75	35
Glass	10	10
Metal	280	280

Source: GIZ/MLPS

Based on the quantities of recyclables to be recovered and the current market prices, the following table shows the expected revenues from sale of recyclables for the four options (2021 as base year).

Table 8-17: Expected revenues from recyclables and RDF, EUR/year

Recyclable materials	Option 1	Option 2	Option 3
Materials separated from separately collected	372,000	372,000	372,000
Materials separated from residual waste	-	332,000	332,000
RDF	-	-	-33,000
Total	**372,000**	**704,000**	**671,000**

Source: GIZ/MLPS

8.5.5 Conclusion

As seen from the assessment of the three options, Option 1 has the lowest implementation costs while the Option 3 is the most expensive option. The sorting costs are compensated by the revenues from sale of recyclables only in case of Option 1 (not taking into account the separate collection costs).

Option 2 achieves almost double recycling rates in comparison with Option 1 but its considerably more expensive. Nevertheless, the recycling of additional 7% from generated municipal waste does not justify the additional costs.

Option 3 allows the achievement of highes recovery rate (>20%) but its implementation is also disputable because of current restrictions on co-incineration of waste imposed by the national legislation and the uncertain market for RDF in the country.

Despite of these limitations, Options 1 and 3 are retained for further assessment of the possible system options.

8.6 Technical options for treatment of biodegradable municipal waste

The treatment of MSW can achieve the following three main objectives:

- To reduce the negative impact of waste on the environment. Because of its capacity to degrade, biodegradable waste is the main source of pollution in landfills, by creating carbon dioxide and methane emissions. Waste treatment aims to ensure that waste has the least negative impact on the environment;
- To increase resource efficiency. Waste is a potential resource for re-usable materials and energy;
- To increase the lifetime of landfills. By extracting valuable materials from waste, using it as an energy resource, and/or by stabilizing the biodegradable fraction, the quantities of waste to be landfilled will be decrease significantly. Although waste treatment can reduce requirements for a landfill, it cannot remove the need for a landfill.

Several waste treatment technologies are available. Most important technologies are:

- Incineration of waste;
- Waste to Energy technologies;
- Mechanical biological treatment (MBT) linked with centralized composting;
- Green waste composting; and
- Home composting.

The sections below present an analysis of these possible options.

8.6.1 Treatment methods for residual municipal waste

Residual waste may be treated directly from the waste stream with only minor preparation, or can be converted in to other usable forms by pre-treatment processes. There are a number of final treatment options available for residual wastes. These are split into two categories:

- Pre-treatment options and subsequent processing measures for separated waste; and
- Techniques for directly treating mixed wastes.

Pre-treatment options generally aim to remove a proportion (likely to be up to 10%) of residual recyclable materials from mixed waste streams. Stages of mechanical, biological or heat treatment are then used to break down the remaining waste in to Refuse Derived Fuels (RDF), for use in energy generation, and other stabilised products which may be used to improve certain low quality soils, in the reclamation of mines and quarries or for landfill cap restoration.

Mechanical Biological Treatment (MBT) describes a series of processes which include the mechanical sorting of waste followed by a phase of biological treatment. The outputs from the process are recovered recyclables, a Refuse Derived Fuel (RDF) and a low quality, stabilised ‘compost-like’ output (CLO). Recyclables recovered from this process are of much lower quality than those from source-segregated waste, due to greater levels of mixing and increased potential for contamination with other materials. CLO is lower quality than compost produced from segregated biodegradable waste and this product is usually landfilled, requiring less volume and generating fewer methane emissions than landfilling of the original, untreated waste.

Biodegradable outputs recovered from pre-treatment may undergo additional treatment to recover nutrients. **Anaerobic Digestion** (AD) is an increasingly popular treatment and produces a solid organic residue, a run-off 'liquor' which can be used as a plant fertiliser, and biogas which can be burnt in conventional energy generation. **Composting** is also used to convert suitable biodegradable waste in to a soil improver. Materials recovered from pre-treatment are not ideal for AD treatment or composting as they tend to be mixtures of materials, containing a proportion of non-degradable components which reduce the quality of the outputs and the efficiency of the process.

Incineration, pyrolysis and gasification are all thermal treatments, commonly referred to as Energy from Waste (EfW) processes. They use heat to liberate energy from residual wastes, which in turn is used for heating and electricity generation, and reduce the volume of waste for final disposal.

Incineration, or co-incineration involves the full, high temperature (>850°C), combustion of waste in controlled conditions, in the presence of oxygen, in a conventional furnace. Incineration results in a number of gaseous emissions including carbon dioxide, acid gases, dioxins and furans, heavy metals and particulates, which present the potential for negative climatic and environmental effects. Incineration also produces a stable, solid ash residue (representing ~10% of the original mass) which can be used as a secondary aggregate in construction applications dependent upon its chemical and physical properties, which relate to the original feedstock.

Pyrolysis describes low temperature (400-800°C) processing in a zero, or low oxygen, environment. Pyrolysis results in the production of combustible synthesis gas (syngas) which can be used in power generation, char and fuel oil. Char (representing ~90% reduction from the original mass) can be used as a Refuse Derived Fuel (RDF), soil improver or recycled (secondary) aggregate in construction applications depending upon its chemical and physical properties, which relate to the original feedstock.

Gasification describes high temperature (900-1400°C) processing in a low oxygen environment. Gasification results in the production of combustible synthesis gas (syngas) which can be used in power generation. The residual char (representing ~90% reduction from the original mass) can be used as a recycled (secondary) aggregate in construction applications dependent upon its chemical and physical properties, which relate to the original feedstock.

8.6.2 Waste-to-Energy Technologies

Waste-to-Energy (WtE) encompasses methods whereby energy entrapped in waste is extracted for the production of electricity and heat. Globally, about 900 thermal WtE plants are operational, which treat annually 200 million tonnes of MSW. WtE also has a positive climate change effect because one tonne of incinerated rather than landfilled municipal waste reduces emissions of greenhouse gases (GHGs) by about 1.2 tonnes of CO_2. Although WtE plants produce CO_2 as a result of the production process, the greenhouse effect of untreated methane generated in landfills is significantly more damaging.

Waste incineration is most widely implemented WtE technology that leads to significant reduction of the quantities of waste to be disposed – and about 95% of the waste is combusted.

Although such reduction decreases significantly the need for construction of landfill for non-hazardous waste, the resulting 5% output from the incineration is qualified as hazardous waste in the EU and needs to be disposed safely on special landfills for hazardous waste.
Incineration of waste is an activity associated with highest investment costs for waste treatment and can only be justified with significant amounts of waste generated within the project area. Costs associated with MSW incineration in EU countries are within the range of 25-45 €/t (operational and maintenance costs) or 100-200 €/t (total costs). It is commonly accepted that incineration of waste can be justified only when quantities of waste exceed 100,000 tonnes per year, and even then incineration is seldom a preferred technology. Since the quantities of generated municipal waste in WMZ are much lower than those above, the associated unit costs will be even higher and utterly unaffordable. Therefore, the implementation of MSW incineration or other thermal treatment technologies in WMZ 8 is not considered further in this report.
Apart from waste incineration (as previously described), there are various other technologies available for WtE treatment. The majority of gasification and pyrolysis processes are recently under development and not widely implemented technologies in municipal waste treatment. Costs associated with thermal depolymerisation, pyrolysis, and plasma arc gasification are similar to incineration of municipal solid waste. Costs associated with anaerobic digestion in EU countries are within the range of 25-50 €/t (operational and maintenance costs) or 50-90 €/t (total costs), and may not be technologically reliable when applied to mixed MSW. Like incineration of MSW, implementation of thermal WtE technologies in WMZ 8 would prove too costly and the SWM service costs would rise to a level that would make the cost recovery unattainable. Therefore, the implementation of WtE technologies in WMZ 8 is not considered further in this report.
However, as the costs related to non-thermal technologies, especially MBT, are considerably lower than the thermal technologies, the following section will provide analysis of possible options for mechanical-biological treatment in the project area.

8.6.3 Mechanical-Biological Treatment

MBT is a family of technologies with widely varying costs and complexities. MBT technologies are very well established technologies in EU countries. Various technologies are currently in operation as the different processes have been tested and optimised over a long period of time.
The development of MBT technologies was encouraged by changes in the overall EU waste management policy and certain targets imposed. These include:

- Prohibition for disposal of untreated MSW; and
- Reduction of quantities of biodegradable waste for landfill.

MBT could incorporate a number of different process technologies. Some systems include facilities to pre-screen the waste and thus produce a compostable fraction appropriate for outdoor, covered or in-vessel type of composting processes. Another MBT approach includes initial extraction of recyclables, followed by homogenisation of the residual waste prior to its processing in an anaerobic digestion plant or aerobic treatment plant.
Based on the type of biological treatment, MBT can be basically divided into three main technologies:

- Bio-stabilisation. This technology involves extraction of recyclable materials followed by bio-stabilisation of the remaining biodegradable waste fraction, done in aerobic environment, prior to disposal in landfill or use in non-agricultural applications such as mine reclamation;
- Bio-drying. With this technology a solid refuse fuel (SRF) is produced through intensive aerobic treatment of the municipal waste. The production of this high calorific fraction follows the extraction of recyclable metals and inert materials;
- MBT with energy recovery. With this technology a different high calorific fraction (refuse derived fuel – RDF) is produced. Following the extraction of recyclable materials and inert materials, the lighter fraction is prepared for production of RDF with parallel aerobic/anaerobic treatment of the heavier fraction.

The table below presents the costs associated with the above presented MBT technologies in EU countries.

Table 8-18: Costs related to MBT technologies

MBT type	Operational costs (EUR/t/y)	Total costs (EUR/t/y)
Bio-stabilisation	10 - 25	20 - 40
Bio-drying	20 - 35	40 - 70
Energy recovery	25 - 45	60 - 90

Source: GIZ/MLPS

As shown on the table above bio-stabilisation is the least costly method. Having in mind the current socio-economic situation in the region, possible implementation of the advanced waste treatment should envisage the lowest-cost solutions.

Bio-stabilisation process can be done in several ways. One of the well tested technologies is treatment of biodegradable fraction in in-door tunnels (so called in-vessel aerobic treatment). This process allows for fully controlled process of stabilisation and takes between 18 and 28 days, which allows for larger number of aerobic treatment cycles and thus needs considerably less area for treatment and stabilisation.

The in-vessel aerobic treatment is a fairly sophisticated method of treatment of biodegradable waste. It leads to production of a stabilised output, which can be landfilled or used in different productive applications, depending on its quality, while reducing in the process the quantities to be disposed, compared to the input amounts. More importantly this compost-like-output (CLO) can be used for rehabilitation of sand quarries or other disturbed lands. The process is conducted in aerobic environment and fully automated.

For the purposes of the current analysis, the design capacity of the plant is 40,000 tonnes of mixed MSW per year.

Mechanical treatment of the mixed waste stream

Following the registration of the incoming waste trucks, the waste is directed to the facility for mechanical waste treatment, where waste is unloaded at a reception area where preliminary examination and sorting of bulky waste is conducted. After that, a front loader feeds the appliance for shredding the oversized fractions and opening the plastic bags. Through conveyor belt waste is transported to a trommel/drum sieve. This trommel has a three section sieve, which separates the throughput into three main fractions:

- Between 0 and 60 mm, which contains maximum quantity of biodegradable fraction mixed with quantities of small plastics, pebbles, wood chips etc.;

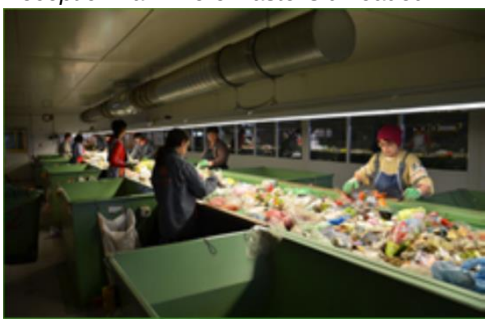
- From 60 to 250 mm, which contains maximum quantity of recyclable fractions – PET, PE, foils, ferrous and non-ferrous metals, paper and cardboard. This fraction will be transported to a ballistic separator, which additionally separates the throughput into: organic fraction for biological treatment and recyclable fractions for manual sorting and baling; and
- Above 250 mm, this contains oversized packaging and large foils. This fraction will be transferred to the station for manual sorting and subsequent baling.

The figure below shows some of the main mechanical treatment steps:

Figure 8-6: Main mechanical treatment steps

Reception hall where waste is unloaded

Three-section drum sieve



Station for manual sorting

Baler for recyclable fractions

Source: GIZ/MLPS, MBT plant in Varna, Bulgaria

The residual from the middle-sized and the oversized fractions is transferred to the landfill for disposal.

Biological treatment of the remaining output

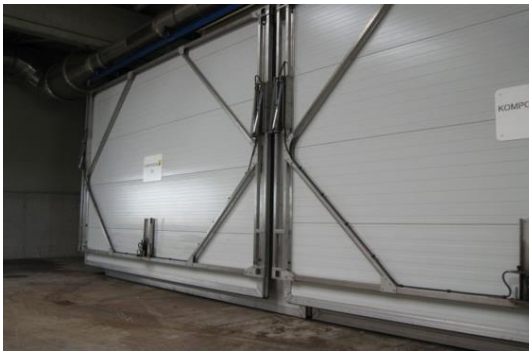
Following the mechanical separation of the recyclable fractions, the biodegradable fraction is transferred to the in-vessel composting facility, comprising of closed tunnels, where the input material falls in an entirely controlled environment. The process is automated to control the oxygen content, temperature and humidity.

The aeration appliance is installed in the concrete floor. The input material stays in the tunnels for 20 days. The organic material is subjected to several phases of treatment, each of which occurs “naturally” provided that adequate conditions of temperature, moisture and oxygen are maintained:

- First phase: Stabilization, which is happening at 30ºC;
- Second phase: Hygienisation, which takes place at 60ºC;
- Third phase: Composting, which takes at 55ºC; and
- Fourth phase: Cooling, at 35-40ºC.

The malodorous air will be captured in bio-filters, prior to releasing it into the open air.
The bio-filters consist of a concrete reservoir, which has two beds. The malodorous air is insufflated into the lower bed, below the bio-filter, and from there it is dispersed evenly to the bio-filter material.
The biological treatment phase is completed in a separate zone for further maturation of the treated output; this may require 6-8 weeks.
The figure below shows some of the main biological treatment steps:

Figure 8-7: Main biological treatment steps



Outside look of the composting tunnels

Inside the composting tunnels

Cooling process

Maturation process

Source: GIZ/MLPS

In the table below are presented the key design parameters, used for dimensioning the MBT plant.

Table 8-19: Parameters for dimensioning the MBT plant

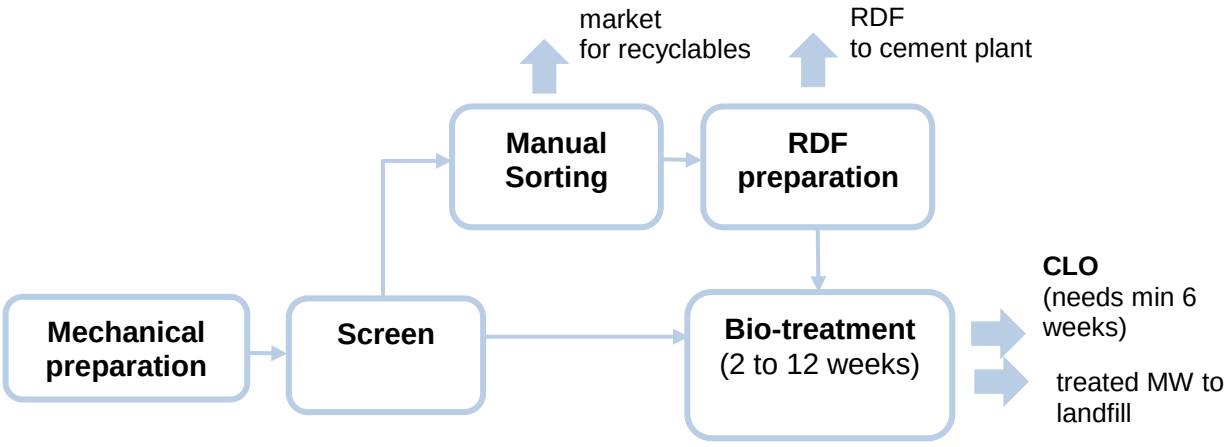
Parameter	Unit	Value
Capacity (design)	tonnes	36,000
Daily input	tonnes	96
Recyclables extracted	%	8%
Yearly input for biological treatment	tonnes	30,100
Daily input for biological treatment	tonnes	78
Time needed for biological treatment stage 1 (intensive, tunnels)	weeks	2
Time needed for biological treatment stage 2 (maturation, windrows closed)	weeks	4
Assumed density	t/m^3	0.4

Parameter	Unit	Value
Capacity of one tunnel	m^3	525
Aerated tunnels	№	5
Loss during biological treatment	%	26.4%
Loss during biological treatment	tonnes	9,200
CLO produced (50% of biological treatment output)	tonnes	10,500
Total waste for landfill (if CLO landfilled)	tonnes	21,000
Landfilled waste with CLO (% of input)	%	59%

Source: GIZ/MLPS

The figure below presents the block diagram of the analysed MBT system.

Figure 8-8: MBT plant block diagram



Source: GIZ/MLPS

Options for additional sources for utilisation of CLO should be further explored. As seen from the table above, a possible utilisation of CLO will reduce the quantities of waste landfilled considerably.

With regard to a possible energy recovery from this MBT option, the stabilised output can be further treated (dried), which will result in production of high-calorific fraction as refuse-derived fuel (RDF). The production of RDF will certainly require adjustment of the mechanical treatment stage. Following adoption of appropriate regulations in accordance with EU norms, this RDF can be utilised in the existing cement industries in the country.

Cost estimation

The total investment costs associated with the construction of this MBT plant amount to about 14.7 million EUR. The investment breakdown is presented in the table below (figures are rounded).

Table 8-20: Estimation of investment costs for the MBT

Investment	Value, EUR
Civil works	6,905,000
Mechanical and equipment	9,472,000
Vehicles	470,000
Total investment cost	**16,847,000**
Annualised investment costs	909,000
Average incremental investment costs, €/tonne	46.2

Source: GIZ/MLPS

Depreciation of buildings is calculated for the entire planning period – 25 years. Depreciation of equipment is calculated for half of this period as it needs to be replaced.
Costs associated with the operation and maintenance of the facility are given in the table below.

Table 8-21: Estimation of O&M costs for the MBT

Operational costs	Value, EUR
Maintenance and repair	400,000
Personnel	103,000
Consumables	282,000
Transportation of residues to landfill	82,000
Transportation and treatment of RDF	57,000
Administration	82,000
Taxes, insurance	47,000
Total O&M cost	**1,054,000**
Average incremental operating costs, €/tonne	32.3

Source: GIZ/MLPS

The total annual costs for treatment of one tonne of MSW in such a MBT facility are estimated at about 78 EUR. These costs do not include the expected revenue from recycling, which are estimated to reduce the annual costs by 12 EUR/tonne.

Conclusion

Although the implementation of MBT in NDR brings rather high costs, this option will be retained for further analysis of the options for establishment of waste management system in WMZ 8. Reduced quantities of waste to be landfilled will lower the investment costs for construction of new sanitary landfill for the region.

8.6.4 Treatment of separately collected green and bio-waste

The treatment of green waste in WMZ 8 could be initiated with relatively simple methods, like chipping of tree cuttings and composting that requires a minimum of pre-processing and

which will result in the highest quality of final product. The produced compost can be used as a soil conditioner and will be suitable for agricultural and other applications.

Collection of Green Waste

Green waste originates from public parks, cemeteries and maintenance of green areas on the premises of companies and around blocks of flats.

Green wastes from the maintenance of green areas today are already transported separately to the landfills. It therefore only needs the following activities:

- Instruct the gardening companies, which maintain the green areas, to strictly separate green waste and waste from litter baskets, etc.
- Ban the delivery of green waste to the disposal facility, diverting the waste to the green waste composting plant or plants.

Collection of green waste from private gardens is more difficult system, given that the waste is generated in comparably small quantities per generator throughout the year, with peaks in Spring and Autumn. There are the following possibilities of collection:

- Deposit green waste as it appears, i.e. place the waste on the kerb-side immediately as it is produced, in the same way as bulky waste presently.
- House to house collection once per month, at specified dates, between March and November
- Placement of green waste containers (7 to 10 m^3) at certain places covering an area of 500 m to 1 km radius, in family house and garden areas, once a month during Spring, Summer and Autumn;
- Collection on call, several times a year free of charge, further collections at a certain fee;
- Installation of amenity sites for green waste, where people can bring their green waste free of charge. Such amenity sites might also work as interim storage for the green waste, until the mobile shredder comes from time to time and shreds the green waste. It then is transported to the green waste composting plant.

In the following table, the different collection systems are compared:

Table 8-22: Comparison of different garden waste collection schemes

Criteria	Option 1 Deposit as Waste appears	Option 2 Weekly House to house collection	Option 3 Placement of Green Waste Containers	Option 4 Collection on call	Option 5 Amenity site with storage
Convenience for waste producer	Very convenient, because waste is collected immediately	Convenient collection system for the producer. Given the weekly collection, also very wet wastes do not pose a major problem	Relatively convenient scheme, since the containers would be placed at a convenient distance	Convenient collection of the waste from the premises. Inconvenient, because the cutting of trees and bushes to be coordinated with the arranged collection.	Inconvenient, because waste producers must transport the waste to the amenity site over several km. Not every waste producer has a suitable vehicle. Convenient from the point of view that the waste can be removed whenever it appears.
Convenience for the local authorities	LA must permanently organise ad hoc collection of green waste	LA must organise collection at relatively high costs.	LA has to organise dates, when containers are placed.	Collection company is to organise best collection route.	Operation of several amenity sites (coverage 5 to 10 km diameter) is required.
Quality of waste	High quality, because only green waste will be picked up. Green waste is fresh.	High quality, because only green waste will be picked up. Green waste has an age of maximum 1 week.	Medium quality, the containers may also be used for bulky waste and construction waste. Green waste may have been stored for some time.	High quality, because only green waste will be picked up. Green waste may have been stored for some time.	High quality, because only green waste will be accepted. Green waste is fresh.
Quantities	Complete generated quantity is collected	High quantities of Green Waste collected from those having applied for a Green Waste bin.	Reduced quantity collected. Green waste may be mixed with MW	Reduced quantity collected. Green waste may be mixed with MW	Reduced quantity collected. Green waste may be mixed with MW
Risks	None	Green waste is placed on the kerb-side whenever it appears	Green waste is placed on the kerb-side whenever it appears	Green waste is placed on the kerb-side whenever it appears	Green waste is placed on the kerb-side whenever it appears
Comment	System is similar to existing bulk	This is a well organised system.	In principle good system, however, there is	This system keeps the settlements	This option makes sense, if an amenity site system is

Criteria	Option 1 Deposit as Waste appears	Option 2 Weekly House to house collection	Option 3 Placement of Green Waste Containers	Option 4 Collection on call	Option 5 Amenity site with storage
	waste collection system. Relatively expensive, but most convenient for waste producers	Relatively expensive, but very convenient for waste producers	a high risk, that there will be other waste in the containers. The system should be tested before introduction.	clean, since waste only is placed at the arranged date. However, there might be many people, who would not like the call system.	foreseen for other waste types, too. Not suitable for rural areas
Recommendation	Recommended, based on existing system, where bulky waste collection already works on an ad-hoc basis, until a more organised system is introduced.	Not recommended in short term. In mid term introduction of a voluntary bin system for green waste could be considered in the future.	Not recommended until there is a sustainable discipline in waste separation.	Not recommended. Given the high frequency of grass cuttings this would require frequent calls and collection. Thus a regular system is better suited.	Not recommended. It is unlikely, that a considerable number of people will transport their waste to amenity centres.

Source: GIZ/MLPS

Taking the final decision whether to implement green waste separate collection for households the following factors shall be taken into account:

- The estimated quantities of green waste in rural areas are relatively small and correspond to approximately 17.5% of the total waste generated or 26 kg/capita/year. These amounts are lower than expected and most likely significant proportion of green waste is already home composted or burned in the gardens.
- Considering that the majority of households are involved in growing fruits and vegetables and animal breeding the separate collection of green waste in rural areas could potentially bring significant excessive amounts of agriculture biomass and animal manure.
- Family house areas are also those where home-composting is recommended.

As mentioned before, presently green garden waste is still burned in the gardens and thus the collection system only becomes necessary, once the burning option is forbidden and the requirements are enforced, which is expected in the medium term.

Until this time, the green waste composting could be started with waste collected from the maintenance of green areas, thus having the possibility of testing the composting market and gaining experience with composting.

Composting of green waste

Green and market waste composting is usually carried out in windrows in the open, given that green waste causes low odour emissions. This allows composting at relatively low costs. There are a few larger scale green waste composting plants (up to 30,000 tonnes/year), but the bulk of green waste composting plants are small community composting facilities of several 100 tonnes/year up to 10,000 tonnes/year.

The operation of such small green and market waste composting plants usually operated with mobile equipment, such as loaders, excavators with grapples, shredders and screens. The advantage is that mobile equipment can then be used for servicing several composting places.

Green waste composting yields high quality composts. The bulk of green waste is easily collectable, given that it is mostly generated in quantities, which fill one or more trucks or skips. Green waste is quite clean in terms of heavy metals and unwanted waste.

Given the simplicity of the green waste composting and the easily available green waste material (except for garden wastes), green waste composting is recommended to be implemented in project area.

The main difference between green waste composting and the bio-stabilisation of mixed organic waste is that in order to produce a high quality compost, which can be applied for various purposes (and be diverted from landfill), the method requires that the input material is separately collected to avoid contamination of the final product.

The composting activities aim at achieving:

- Reduction of organic waste in the total waste flow for landfilling; and
- Return of part of the organic fraction for reuse.

Composting of separately collected green waste includes unloading of throughput in a designated site, shredding it and placing it windrows. For aeration purposes, the material needs to be regularly turned by a heap turner, or specially designed equipment as shown in the pictures below.

Figure 8-9: Turning of windrows

Windrow turner

Tractor driven self propeled turner

Source: GIZ/MLPS

Regular tests need to be performed on the temperature, humidity and fertility of the compost. To produce a quality product (compost), which could be used for agricultural purposes, periodic analysis of heavy metal content need to be conducted. Lower qualities of compost are appropriate for land reclamation and construction of sports fields, highway landscaping and other applications.
In the process of composting, microorganisms break down organic matter and produce carbon dioxide, water, heat, and humus, the relatively stable organic end product. Under optimal conditions, composting proceeds through three phases: 1) the mesophilic, or moderate-temperature phase, which lasts for a couple of days, 2) the thermophilic, or high-temperature phase, which can last from a few days to several months, and finally, 3) a several-month cooling and maturation phase.
Different communities of microorganisms predominate during the various composting phases. Initial decomposition is carried out by mesophilic microorganisms, which rapidly break down the soluble, readily degradable compounds. The heat they produce causes the compost temperature to rapidly rise.
As the temperature rises above about 40°C, the mesophilic microorganisms become less competitive and are replaced by others that are thermophilic, or heat-loving. At temperatures of 55°C and above, many microorganisms that are human or plant pathogens are destroyed. Because temperatures over about 65°C kill many forms of microbes and limit the rate of decomposition, compost managers use aeration and mixing to keep the temperature below this point.
During the thermophilic phase, high temperatures accelerate the breakdown of proteins, fats, and complex carboydrates like cellulose and hemicellulose, the major structural molecules in plants. As the supply of these high-energy compounds becomes exhausted, the compost temperature gradually decreases and mesophilic microorganisms once again take over for the final phase of "curing" or maturation of the remaining organic matter.
The full composting cycle requires usually takes at least 12 weeks and due to significant loss of water the material loses about 50% of its initial weight.

Chipping of tree cuttings and shrubs

This method is increasingly used by green maintenance companies, especially if disposal costs are high. Companies usually have to pay for the delivery of green waste to composting plants.
The method works as follows: the maintenance company buys a small shredder mounted on a small trailer, which can chip branches up to 5 to 10 cm. With these shredders, they drive to the maintenance area and shred the cuttings. Where suitable, the chipped material is distributed, e.g. under hedges, or in a bushy area, or where the growing of weeds shall be prevented. If this is not possible the chipped material is directly loaded on a truck and brought to a place of the maintained area. There the material is left for some months, in order to degrade and finally can be used as compost.
If this also is not possible, the chipped material is brought to the composting plant.

Kitchen and garden waste (Bio-waste)

Kitchen waste is the most complicated waste fraction to be collected separately.
The separate collection of kitchen waste is not recommended for the project area because of the following reasons:

- The majority of population in WMZ 8 lives in rural areas where animal breeding (chicken, rabbits, pigs, etc.) is still common and most of the organic waste is either

already home-composted or fed to animals. The introduction of separate collection of bio-waste would not yield significant results at present.

- Separate collection of bio-waste in city centres and blocks of flats areas is difficult mainly because of the anonymity of the collection system. Many households did not participate and often the bio-waste was contaminated with other waste. Having this is in mind, it does not make sense to add another container for "kitchen bio-waste". It is first necessary to significantly improve the results of the other materials, before another fraction for source separation should be added.

In addition, the presence of food waste in the collected materials will require the implementation of more advanced treatment technologies like closed composting systems or anaerobic digestion. Such methods are considerably more expensive compared to open windrow composting and will have additional impact on the tarrifs for the provided service.

Alternatives for composting of green waste

The following three options for the composting of green waste are analysed:

- **Option 1:** Composting of separately collected green waste from public areas in centralized composting facility situated at the regional landfill site.
- **Option 2:** Organizing composting of green waste in each rayon. Four composting facilities receiving green waste from public areas to be established – one at the regional landfill to serve Donduseni rayon, second in Briceni, third in Edinet rayon and fourth in Ocnita rayon. Each facility will be equipped with wheel loader, shredder, tractor with trailers, tractor driven self propeled turner, compost refining screen.
- **Option 3:** As alternative to Option 2 composting will be organized directly on agricultural land at several sites in each individual rayon. In this case only mobile composting equipment will be provided. The amount composted at each site shall not exceed 150 – 200 tonnes/year.

All considered alternatives can be extended in the future if green waste collection from households is implemented.

The green waste quantities from public areas in urban settlements are estimated to amount approximately 1000 tonnes/year.

The cost comparison of the three options is presented in the table below.

Table 8-23: Cost comparison of options for centralised composting of green waste

Description	Costs in EUR		
	Option 1	**Option 2**	**Option 3**
Quantities to be treated	1,000	1,000	1,000
Investment costs	**575,000**	**2,213,000**	**1,665,000**
Buildings and works	159,000	448,000	-
Equipment	416,000	1,665,000	1,665,000
O&M costs	**60,000**	**201,000**	**166,500**
Total annual costs	107,000	382,000	362,000
Annual unit cost, €/tonne	112.4	401.7	380.6

Source: GIZ/MLPS

As seen from the table above, Option 1 brings lowest costs of the three options.
It shall be note that costs per tonne for all options considered significantly exceed the usual costs for treatment of green waste. The reason is that the quantities of waste designated for composting are considerably lower than the actual productivity of the proposed equipment on each of the sites.
For that reason Option 1 will be recommended for further implementation considering that in the the future the same equipment can be used for decentralized composting of green waste collected from households.

8.6.5 Home composting

Another practical option for reduction of quantities of waste for landfill is introduction of home composting. Home composting is a recycling method that helps transform quantities of green waste into valuable compost, which can be applied by residents directly into their soil to increase the production of vegetables and flowers. At the same time, home composting results in reduced amounts of waste that require collection, and in this sense it can help reduce costs for waste collection and subsequent management.
In the most ordinary way, the process of composting requires simply piling up green waste. The decomposition process is aided by shredding plants and branches from trees. To speed the process of decomposition proper aeration by regularly turning the mixture should be ensured. Kitchen waste could also be added to the process, but only selected food waste. Dairy products and meat should be avoided as they attract vermin and rats. In general, kitchen waste in the rural settlements is primarily used for animal feeding and home composters are expected to treat mainly green waste from yards.
Home composting can be facilitated by use of special devices. These devices (home composters) are stable (usually made of plastic) and have an operational period of 7-10 years. Prices of such composters vary between 25 and 100 EUR.
A home composting unit can also be made from wood, or other materials, and can be very simple and less expensive.
The proposed home composting programme is based on the following assumptions:

- the home composting programme will cover approximately 20% of the households in the WM Zone in 2021
- the numner of household participating in home composting will grow with 5% on annual basis until 50% population coverage is achieved
- the quantities of home composted per capita per year will be 30 kg in urban areas and 20 kg in rural areas
- the unit costs for one composter will be 30 €/pcs
- the accepted lifetime of composter is 7 years
- the communication and public awareness costs will be 1.00 € per household participating once per five years, starting from 2021.

The table below presents the design parameters of a potential home composting system for the individual houses in WMZ 8.

Table 8-24: Parameters for home composting system

Parameter	Unit	Value
Organic waste generated in villages (percent of total organic waste)	%	60%
Organic waste generated in urban areas with houses (of total organic waste)	%	29%
Quantities of organic waste	tonnes/year	15,100
Quantities to be home composted (2021)	tonnes/year	942
Quantities to be home composted (2040)	tonnes/year	1,961
Households covered (2021)	No	13,991
Households covered (2040)	No	29,131
Initial investments	€	420,000
Present Value (PV) of the investments	€	1,303,000
Average Incremental Costs per tonne composted	€/tonne	82.92

Source: GIZ/MLPS

As seen from the table above, the implementation of home composting programme to cover approximately 50% of households living WMZ 8 will require significant investments. At the same time, the quantities to be diverted from landfill cannot be expected to exceed 2,000 tonnes annually.

For that reason, the recommendation is the cost for the composters to be borne by the individual households and not included in the public investments. The major efforts of local authorities will be focused on the financing and implementation of public awareness campaigns.

It is also advisable that home composting is initiated and tested on a pilot basis.

8.6.6 Conclusion

Based on the analysis of possible options for biological treatment of municipal waste, it can be concluded that the following options shall be retained for further analysis of the system elements of the future waste management system in WMZ 8:

- Development of centralised mechanical-biological treatment of mixed collected municipal waste;
- Development of 1 composting plant for separately collected green waste located at the future landfill;
- Introduction of home composting.

8.7 Technical options for disposal of municipal waste

The necessary landfill capacity is defined based on waste generation forecasts and the plans for extension of municipal waste collection services. The reduced quantities of waste to be landfilled as a result of planned establishment of separate collection of recyclable waste and composting of green waste are taken into account.

It is assumed that landfill will comprise of several landfill cells each of them with estimated lifetime of 5 years. The landfill capacity is estimated to 600 thousands tonnes of waste over

20 years operation period. The minimum size of the landfill site required is 12 ha, assuming a maximum deposition height of 13 m and compacted waste density of 1 tonne/m^3.

The new regional landfill will be designed and operated in accordance with the recent technical standards so as protect human health, prevent nuisance, protect surface and groundwater from pollution and minimise the emission to air of methane.
Independent of all future measures related to waste avoidance, recycling and waste treatment, a certain amount of residual waste will remain for disposal. Thus, sanitary landfills for safe and environmentally compliant disposal are required in any case.
The assessment of potential regional landfill locations in the WMZ 8 identified the current disposal site of Donduseni as the preferable location.
Landfills for municipal waste respond to the requirements for safe disposal of waste that does not have hazardous characteristics, and which is similar to household waste.
Therefore, no waste with hazardous characteristics should be accepted for landfilling.
Landfilling of industrial non-hazardous waste is usually allowed at landfills for municipal waste. However it has to be taken into account that waste different from household is of different compaction parameters and may take much more of the landfill volume than household waste of the same weight.
The design and the construction of the regional sanitary landfill will be conducted in accordance with the provisions of Directive 1999/31/EC on landfill of waste.

8.7.1 Options for waste disposal

The options for waste disposal in WMZ 8 are based on the following main assumptions:

- The future infrastructure for waste disposal should be based on the EU environmental standards and norms, as defined in both the NWMS (2013-2027) and the Regional Waste Management Programs for SDR;
- The proposed site nearby the town of Donduseni is the location of the future regional landfill, as agreed and approved by the local stakeholders;
- There will be only one sanitary landfill serving the entire WMZ 8.

Taking into consideration the possible options for recycling and waste treatment, the following two options for waste disposal are analysed:

- Option 1: The option envisages that the whole municipal waste collected from Donduseni, Briceni, Edinet and Ocnita rayons through the residual waste collection system will be disposed on the new regional landfill.
- Option 2: The option envisages that all mixed collected municipal waste will be subject to biological treatment at the MBT plant and only treated waste will be landfilled whereby the quantities of disposed waste are reduced as well. The MBT plant will be located at the site of new regional landfill in Donduseni.

The landfill construction needs to be executed in phases. The first phase needs to include the following infrastructure:

- First cell with capacity to suffice for 5 to 7 years of disposal;
- Collection and treatment systems for leachate and landfill gas;
- Additional infrastructures, like: weighbridge, fence, office and garage buildings;
- The necessary mobile equipment, like compactor, truck, front loader etc.

Prior to the completion of the first cell, the construction of the second cell should start.
Each of the cells, which will be constructed following the first phase, should have an operational life of not less than 5 years.

8.7.2 Cost comparison of the options for waste disposal

The tables below presents the estimation of costs related to the two options for waste disposal.
For the purposes of preparing cost estimates 5 years life time of individual cells is accepted.

Table 8-25: Estimation of investment costs of the two options, 2021, in EUR

Description of costs	Option 1		Option 2	
	Initial investment	Following investments	Initial investment	Following investments
1.Ground	-	-	-	-
2. Civil works and common infrastructure	1,942,000	-	1,407,000	-
3. Construction of Cell 1	1,459,000	-	1,106,000	-
4. Construction of subsequent cells	-	4,133,000	-	2,957,000
5. Cells closure	-	1,549,000	-	1,112,000
6. Mechanical	46,000	50,000	46,000	50,000
7. Mobile equipment	759,000	759,000	759,000	759,000
Total investment cost	**4,206,000**	**6,491,000**	**3,318,000**	**4,878,000**

Source: GIZ/MLPS

The table below presents the expected operational and maintenance costs for the two landfill options.

Table 8-26: Estimation of operating costs, 2021, in EUR

Cost description	Option 1	Option 2
Salaries	23,000	23,000
Maintenance and repair	111,000	102,000
Consumables	89,000	54,000
Leachate treatment	25,000	18,000
Other costs (monitoring, aftercare)	14,000	14,000
Administration	41,000	33,000
Taxes, insurance	6,000	5,000
Total O&M costs	**310,000**	**248,000**

Source: GIZ/MLPS

As it can be expected, Option 2 is the lower cost option, both as investment and as operational costs. The average cost per tonne of waste landfilled during the planned period are 32 €/tonne for Option 1 and 41 €/tonne for Option 2.
Since implementation of mechanical-biological treatment is a possible element of the future regional waste management system, both options for waste disposal shall be retained for further comparison of the possible waste system scenarios.

8.8 Analysis of alternatives for the integrated waste management system

8.8.1 Introduction

Waste collection and sanitary disposal represents the backbone of an integrated waste management system. Each element of a waste management system has an impact on the other elements and therefore they must be fully assessed as a coherent system.
Certain elements (particularly waste treatment options) bring higher costs to the system, but at the same time they support the achievements of environmental objectives and bring positive aspects like revenue and reduced landfill investment costs.
This section looks at several different options, in order to identify the likely scale of costs and benefits which may result from different scenarios of more intensive recycling and treatment in WMZ 8.
The following table presents the options for different elements of the system, which have been retained for analysis of the system options.

Table 8-27: Description of the potential options for each activity

Activity	Description
Collection	**Option 2**: individual houses in the towns of Donduseni, Briceni, Edinet and Ocnita are served by "door-to-door" collection (with 120 l plastic bins assigned to individual households), while the rest settlements are served by "bring system".
Separate collection	• **Option 1:** Separate waste collection is organised in the entire WM Zone 5 in 3 colored plastic 1.1 m^3 containers - one for paper and cardboard, one for plastic and metal and one for glass
Transfer	Two transfer stations (TS) will be established in Briceni and Edinet rayons
Sorting	• **Option 1** – one sorting station (SS) will be established at the Edinet transfer station and will receive all separately collected materials from WMZ 8. • **Option 2** – one centralized sorting facility for separately collected waste and residual waste fractions collected from the entire WMZ 8 will be established at the regional landfill in Donduseni. • Construction of additional sorting facilities will not be required in case of MBT plant
Composting	• **Option 1** – a centralized site for open composting of green waste collected from public areas will be established at the regional landfill.
Home composting	• Implemenation of home composting (HC) programme for family houses and rural areas in WMZ 8, starting with 20% of households in 2021 and increasing participation to 50% of households by 2040.
MBT	• Construction of centralised mechanical-biological treatment plant at the regional landfill
Landfills	• **Option 1** – construction of regional landfill for not biologically

Activity	Description
	treated municipal waste prior to landfilling; • **Option 2 -** construction of regional landfill for treated municipal waste in case of construction of MBT.

Source: GIZ/MLPS

In the **Annex 4** option analysis model is presented.

8.8.2 Identification of system options

The table below presents the grouping of the potential system options.

Table 8-28: Possible waste management system options

System elements	System Option 1	System Option 2	System Option 3
Collection of residual waste	Individual houses in the towns of Donduseni, Briceni, Edinet and Ocnita are served by "door-to-door" collection, while the rest settlements are served by "bring system".	Individual houses in the towns of Donduseni, Briceni, Edinet and Ocnita are served by "door-to-door" collection, while the rest settlements are served by "bring system".	Individual houses in the towns of Donduseni, Briceni, Edinet and Ocnita are served by "door-to-door" collection, while the rest settlements are served by "bring system".
Separate collection of waste	Separate waste collection is organised in the entire WMZ 8 in 3 colored plastic 1.1 m^3 containers	Separate waste collection is organised in the entire WMZ 8 in 3 colored plastic 1.1 m^3 containers	Separate waste collection is organised in the entire WMZ 8 in 3 colored plastic 1.1 m^3 containers
Transfer and transport	Two transfer stations (TS) will be established to serve all settlements in Briceni and Edinet rayons	Two transfer stations (TS) will be established to serve all settlements in Briceni and Edinet rayons	Two transfer stations (TS) will be established to serve all settlements in Briceni and Edinet rayons
Sorting of waste	Sorting station (SS) for separately collected materials from the entire WM Zone will be established at the TS in Edinet	One centralized sorting facility for separately collected waste and residual waste fractions collected from the entire WMZ 8 will be established at the regional landfill in Donduseni	No sorting stations will be established The sorting of waste will be provided at MBT plant
Composting of green waste	Centralized site for open composting of green waste collected from public areas will be established at the regional landfill	Centralized site for open composting of green waste collected from public areas will be established at the regional landfill	Centralized site for open composting of green waste collected from public areas will be established at the regional landfill
Home composting	Implemenation of home composting (HC) programme for family houses and rural areas in WMZ 8	Implemenation of home composting (HC) programme for family houses and rural areas in WMZ 8	Implemenation of home composting (HC) programme for family houses and rural areas in WMZ 8
MBT	n/a.	n/a.	Centralised MBT plant at the regional landfill
Landfills	Construction of regional landfill at Donduseni for	Construction of regional landfill at Donduseni	Construction of regional landfill in Donduseni for

System elements	System Option 1	System Option 2	System Option 3
	untreated municipal waste		treated municipal waste in case

Source: GIZ/MLPS

All system options contain similar provisions with regard to collection of recyclables, collection of residual waste and composting, taking into account the analysis and recommendations from the previous sections. The key differences between the alternatives are the treatment of residual waste fraction in specialized sorting plant or MBT. With regard to waste landfilling the different system options require different disposal capacities.

System Option 1 can be considered as "baseline" scenario with construction of new sanitary landfill in Donduseni, extended waste collection service, organized separate collection of recyclables in the entire WM zone and composting of green waste.

System Option 2 introduces a pre-treatment of waste prior landfilling. For that purpose a sorting plant will be constructed at the regional landfill. The sorting plant will receive both separately collected waste and the residual waste from the entire WMZ 8.

System Option 3 extends the pre-treatment of residual waste, envisaged in Option 2 through introduction of biological treatment of residual waste fraction in MBT established at the regional landfill.

8.8.3 Cost assessment of system options

The table below presents the estimation of the investments needed for each of the six system options.

Table 8-29: Estimation of the initial investments needed for the options, 2021, EUR

System elements	Option 1	Option 2	Option 3
Waste collection	3,552,000	3,552,000	3,552,000
Separate waste collection	363,000	363,000	363,000
Transfer stations	997,000	997,000	997,000
Sorting facilities	847,000	3,386,000	0
Composting facilities	575,000	575,000	575,000
Home composting[10]	0	0	0
MBT	0	0	16,847,000
Landfills	4,206,000	4,056,000	3,318,000
Total costs	**10,541,000**	**13,420,000**	**25,658,000**

Source: GIZ/MLPS

The table below shows the discounted unit costs for collection, treatment and disposal (included are initial investment costs, investment costs for the future development of landfill and cells closure, replacement of assets and operating cost) of the three system options. The table includes also the expected revenues from recycling (presented as negative values/costs) as well as the total recovery/diversion rate associated with each of the options.

[10] Investments for composters not envisaged for pu/blic investments

Table 8-30: Estimation of the specific annual costs related to the system options, 2021, EUR

Components	Option 1	Option 2	Option 3
Waste collection	30.2	30.2	30.2
Separate waste collection	4.4	4.4	4.4
Transfer stations	6.9	3.2	3.2
Sorting facilities	5.5	28.1	0.0
Composting	3.5	3.5	3.5
MBT	0.0	0.0	65.8
Landfills[11]	26.4	24.6	20.7
Sub-total costs	**76.8**	**97.8**	**131.5**
Revenue from recycling	-13.1	-22.6	-22.5
Total costs	**63.7**	**75.2**	**109.0**
Recovery/diversion rate, %	**12.4%**	**24.8%**	**48.0%**

Source: GIZ/MLPS

From the table above it is clear that all three options meet the recovery objectives and Option 3 (MBT) achieves the maximum reduction of quantities to be landfilled. It has to be noted that it is assumed that 100% of the produced CLO will be landfilled (Option 3).
The achieved recovery and landfill diversion rates (Option 2 and Option 3) include production and recovery of RDF. These figures shall be interpreted with a significant level of uncertainty because of the present restrictions on co-incineration of waste imposed by the national legislation and lack of reliable markets for RDF.

The above costs are based on preliminary estimates developed during option analysis stage. The final project costs are based on the prepated conceptual design for the recommended alternative and are presented in section 11.

8.8.4 Final assessment of the system options. Conclusion

The final decision about the future integrated solid waste management system to be established in WMZ 8 will be influenced by two main factors. These are:

- Compliance with the national principles and objectives in the field of solid waste management;
- Type of financing of the system.

The National Waste Management Strategy 2013-2017 sets the following principles and objectives:

- Implementation of waste management activities in accordance with the hierarchy adopted on EU level where landfilling of waste becomes the least preferable way of waste treatment and is preceded by waste minimisation, reuse and recycling;

[11] Operating costs at Ocnita landfill not taken into account

- Establishment of resource recovery mechanisms through introduction of separate waste collection and sorting of municipal waste, coupled with implementation of economic instruments which will foster the resource recovery on a national level (like Extended Producer Responsibility).

All presented system options meet these principles and objectives, set on national level.
System Option 1 is expectedly the lowest cost option of all three ones. This is due to the lack of costs for treatment of residual waste. System Options 2 and 3 bring higher rate of diversion of waste from landfill, but the cost associated with pre-treatment of waste prior landfilling are rather high – about 28.1 €/tonne (Option 2) and 65.8 €/tonne (Option 3).
Section11 provides details about the project financing. Regardless of the type of financing, it has to be assured that the selected measures are sustainable. This means that the costs for operating the system and its maintenance could be sustained through the waste charges to the population and the business entities.
The table below presents the division of project discounted unit costs between operating and investment costs of System Options 1 in individual rayons and average for WMZ 8.

Table 8-31: Division of project costs, EUR/tonne generated

Components	Average	Donduseni	Briceni	Edinet	Ocnita
Separate collection					
Investment costs	1.71	1.27	1.26	2.59	1.31
Operating costs	2.75	2.84	2.28	2.98	2.97
Total separate collection costs	4.46	4.11	3.54	5.57	4.29
Residual collection					
Investment costs	12.74	13.53	12.81	10.84	15.00
Operating costs	17.45	18.42	16.34	12.94	25.23
Total residual collection costs	30.19	31.96	29.15	23.78	40.22
Transfer of residual waste					
Investment costs	2.50	-	4.22	3.80	-
Operating costs	4.39	-	8.19	5.94	-
Total waste transfer costs	6.89	-	12.41	9.74	-
Green waste composting					
Investment costs	1.70	1.33	1.24	2.12	1.99
Operating costs	1.66	1.33	1.24	2.04	1.92
Total green waste composting costs	3.37	2.66	2.48	4.16	3.90
Sorting of separately collected waste					
Investment costs	1.88	1.54	1.87	2.00	1.98
Operating costs	3.57	3.46	3.43	3.69	3.65
Total sorting plant costs	5.45	5.00	5.30	5.69	5.63
Landfill					
Investment costs	17.11	16.78	17.41	17.02	17.08
Operating costs	9.30	9.39	9.41	9.20	9.23
Total landfill costs	26.41	26.16	26.82	26.21	26.31
Total investment costs	37.65	34.45	38.80	38.37	37.35
Total operating costs	39.12	35.44	40.90	36.78	43.00
Total costs	**76.77**	**69.89**	**79.70**	**75.15**	**80.35**
Total Revenue	13.08	12.66	12.56	13.54	13.39
Net Costs per tonne	**63.69**	**57.22**	**67.15**	**61.61**	**66.96**

Source: GIZ/MLPS

The table above shows that the operating and maintenance costs are affordable and could be sustained through the future waste tariffs. It is also apparent that grant financing is needed for the initial investment of the project.
Under the assumption that grant financing would be available for the initial investment of the project and taking into consideration the fact that this option is the lowest cost option, the recommendation is that System Option 1 is selected for future development of the integrated solid waste management system in WMZ 8.
The implementation of system Options 2 and 3 requires significantly higher implementation costs and cannot be recommended at this stage. Lack of reliable data about waste composition and existing ban on co-incineration of waste create uncertainties regarding projected revenues and availability of market for RDF and CLO.

The section below presents the recommended system option for implementation – System Option 1.

8.9 Presentation of the preferred alternative

The table below summarises the preferred system for integrated solid waste management system in details.

Table 8-32: Presentation of the preferred system

System element	Description	Capacity[12]
Residual waste collection	Individual houses in the towns of Donduseni, Briceni, Edinet and Ocnita will be served by "door-to-door" collection, while the rest settlements will be served by "bring system"	• 3,292 1.1 m^3 metal containers; • 7,197 120 l plastic bins; • 8 vehicles of 16 m^3; • 8 vehicles of 10 m^3.
Separate waste collection	Separate waste collection is organised in the entire WMZ 8 in 3 colored plastic 1.1 m^3 containers - one for paper and cardboard, one for plastic and metal and one for glass	• 1,555 1.1 m^3 plastic containers; • 1 vehicle of 16 m^3 for Edinet; no additional vehicles required in Donduseni, Briceni and Ocnita (the service will be provided with same vehicles used for residual waste).
Transport and transfer	One transfer stations (TS) will be established at the existing landfill in Niscani to serve to serve all settlements in Briceni, Edinet rayon	• Edinet TS (Edinet rayon) – capacity of 12,000 tonnes/year. • Briceni TS (Briceni rayon) – capacity of 12,000 tonnes/year. • Donduseni – capacity 600 tonnes/year recyclable waste
Sorting of waste	One sorting station (SS) will be	• Capacity of Edinet facility - 4,000

[12] The indicated number of residual waste collection containers and bins do not take into account the existing containers and bins and the reserve for replacement and maintenance (5%)

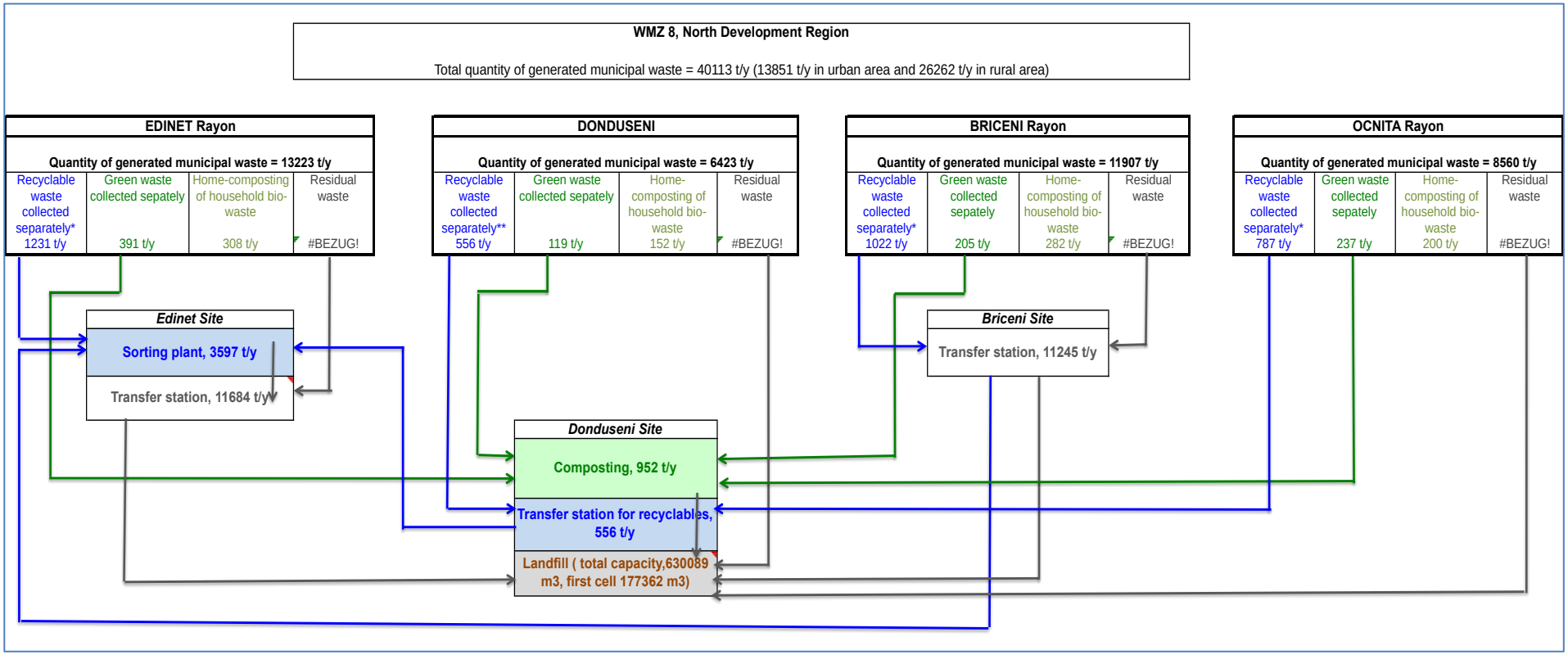
System element	Description	Capacity[12]
	established at the regional landfill and will receive all separately collected materials from Donduseni and Briceni, Edinet rayons. A second small sorting facility will be established for separately collected waste from Ocnita rayon;	tonnes/year of separately collected recyclables
Composting	Centralized site for open composting of green waste collected from public areas will be established at the regional landfill. Implementation of home composting (HC) programme for family houses and rural areas in WMZ 8, starting with 20% of households in 2021 and increasing participation to 50% of households by 2040.	• Donduseni composting plant – capacity of 1,000 tonnes/year.
Waste disposal	Establishment of one regional sanitary landfill for entire WMZ 8 construction of regional landfill for not biologically treated municipal waste prior to landfilling.	• Disposal capacity of about 650 thousand tonnes for 20-year period.

Source: GIZ/MLPS

The figure below present te waste flows in WMZ 8 in 2021.

The Report on site selection for the regional landfill is presented in **Annex 5** and the Report on site selection for the transfer stations in **Annex 6**. The result of topographical surveys and hydrogeological and geological study for the selected sites are presented in **Annexes 9 and 10**.

Figure 8-10: Waste flow chart, IWMS for WMZ 8, 2021



ource: GIZ/MLPS

9 Closure of the existing dumpsites

The identification of the existing dumpsites in WMZ 8 has been carried out based on the following information:

- Database of the Ministry of Environment regarding the existing dumpsites and non-compliant landfill - the existing data base includes the inventory of the main disposal sites in the Republic of Moldova, being developed in 2012 within a project financed under the National Ecological Fund. The existing database of the MoE could be seen at the following link - http://gismediu.gov.md/ro/default/map#lat=69218.625755&lon=196177.884731&zoom=1&layers=_base4,_base5,_base3. The information from the data base on the disposal sites in Development Region North was elaborated within the EU "Waste Governance" project implemented under the European Neighbourhood and Partnership Region (ENPI East).
- Information regarding the current waste management system in WMZ 8, NDR gathered during the elaboration of the feasibility study;
- Information gathered during the site visits for determination of potential transitional waste disposal sites in WMZ 8;
- "Guideline for closure and rehabilitation of disposal sites", elaborated in April 2015 by GIZ (presented in Annex 9).

During the inventory of the current situation for waste management in the WMZ 8 in NDR, were identified that only 20% of the population in zone receives waste collection services, of which 68% in urban area and 2% in rural areas. Based on the waste estimation indicators, the quantity of household waste in project area was estimated about 41,000 tonnes for 2017.
In the waste management zone were identified about 102 dumpsites among which:

- In Donduseni rayon – 39 dumpsites, of which 24 have been authorised;
- In Briceni rayon – 30 dumpsites, of which 2 have been authorised
- In Edinet rayon – 38 dumpsites, of which 7 have been authorised;
- In Ocnita rayon – 30 dumpsites, of which 9 has been authorised;

In general, the collected waste in the project area is taken to a non-compliant landfills or better saying dumpsites, which are usually not fenced, are not monitored, are not equipped with weighbridges, and does not correspond to some requirements for environmental and human health protection.

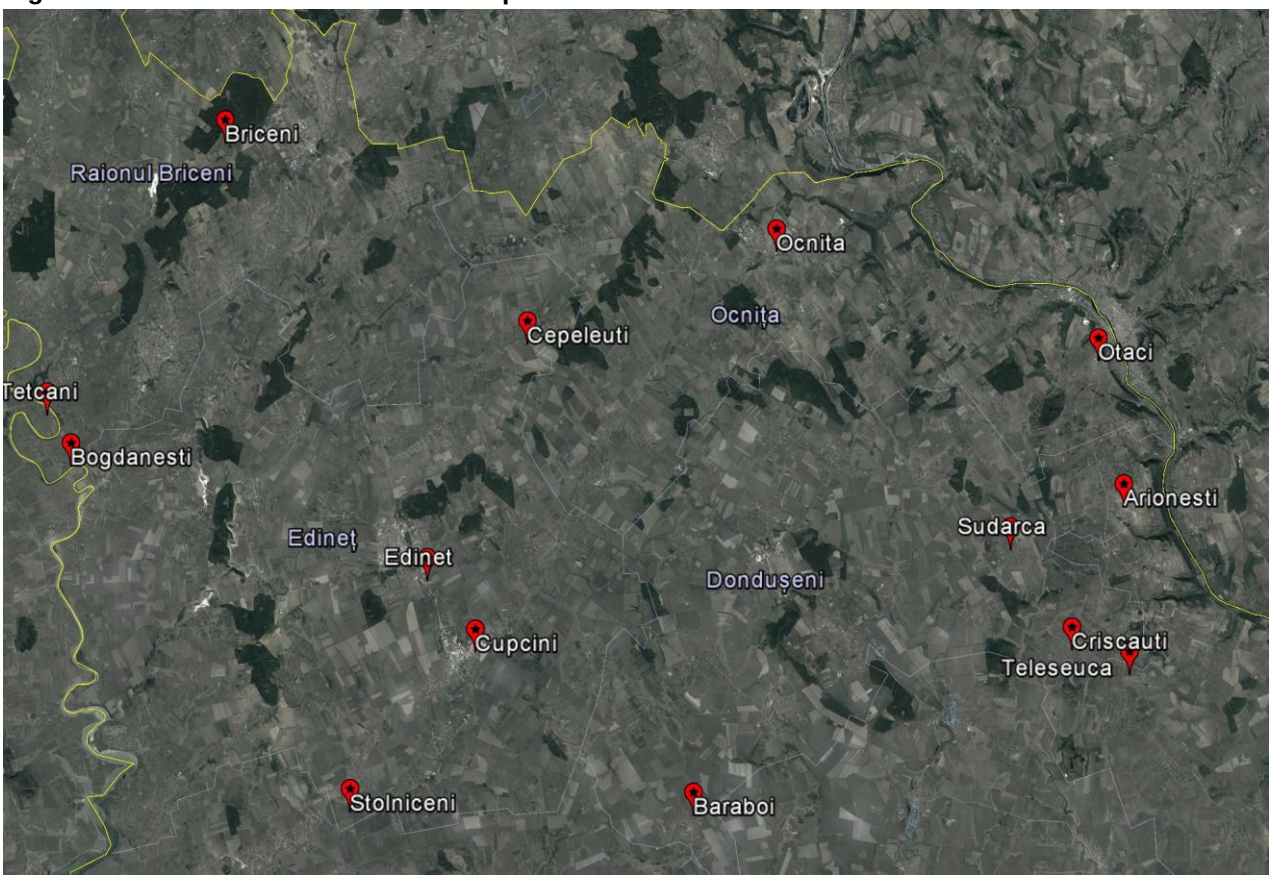
9.1 Proposals for the transitional waste disposal sites

The process of evaluation of waste dumpsites in the project area was based on a 4-steps-criteria approach that covered about 130 dumpsites in the WMZ 8, NDR. In the first two steps dumpsites were preliminary evaluated based on the database of the MoE on inventory of existing dumpsites. Within these two steps have been applied the following evaluation criteria; main municipal disposal sites, distances, legal compliances, available waste collection services.

After this preliminary assessment 14 disposal sites with potential to become transitional waste disposal sites (TWDSs) have been identified. The sites are presented on the figure below.

In the second part of evaluation, the identified sites in Donduseni, Briceni, Edinet and Ocnita rayons have been visited in period 10 October – 10 December 2016. All identified sites were assessed based on following evaluation criteria: legal compliance, availability of disposal capacity of landfill, existing potential for extension, conditions of the disposal site, proximity to the main waste generation centre, accessibility, availability of infrastructure and waste management equipment and environmental and health risks. The evaluation results are presented in **Annex 7**.

Figure 9-1: Potential transitional disposal sites



Source: GIZ/MLPS expert team

Based on outcomes of the field visits and data analysis undertaken for each rayon in the project area the following landfills have been identified as sites appropriate to become TWDSs. These are:

- Arionesti, Baraboi 1, Donduseni, Sudarca and Teleseuca sites in Donduseni Rayon.
- Lipcani, Bogdanesti,Tetcani and Briceni sites in Briceni Rayon
- Edinet, Cupcini, Cepeleuti and Stolniceni sites in Edinet Rayon
- Ocnita and Otaci sites in Ocnita Rayon.

These sites have sufficient capacity and can receive waste generated in the Donduseni, Briceni, Edinet and Ocnita rayons. The transformation of sites into transitional ones will require additional investments in order to improve their operations.
The small distance of Criscauti, Sudarka, Lipcani and Cupcini sites to living areas (200 m) will require additional precautionary measures to reduce ponential odor emission. Such measures can include obligatory daily cover of deposited waste.
The proximity of Donduseni, Briceni and Stolniceni sites to water sources can ce considered as a potential environmental risk. Nevertheless, considering two of these sites serve the main settlements in Donduseni and Briceny rayons and the lack of other alternatives, they can continue operation until the new regional landfill is build
The close proximity of sites in Arionesti, Bogdanesti, Cepeleuti, Otaci and Ocnitato objects of economic activity could also create potential conflicts.
The above sites can continue to operate and become TWDS only in case that additional precautionary measures are taken to reduce the environmental impact by leachate, dust, odour and waste spreading around the site. The improvement measures comprise both technical and operational measures. For example, the technical options shall not be very expensive due to the fact that the ETWDS will be operated only until the regional landfill is built, that is why it is not feasible to have big investment. But, small investments that will improve situation at the dumpsites are needed. Thus, following technical measures are recommended – to install fences around the enhanced dumpsite, gate, information board, dozer and wheel loader, truck hanger with water tank, to build an office, install social container, material storage container.
Regarding the operational measures, it is recommended to hire more staff for the ETWDS (manager, workers, drivers, guard), to develop the operational manual for the dumpsite which will define tasks and responsibilities for all staff, working practices, monitoring and maintenance measures, also obligations for information, documentary records and operation plan.

9.2 General technical provision for closure

The requirements of NWMS regarding closure of non-complied dumpsites presume the identification of inter-communal landfills as transitional ones, until the regional landfills will be built.
The Guideline for closure and rehabilitation of disposal sites (**Annex 8**), developed within the GIZ/MLPS project, defines standard procedures for categorisation of the existing dumpsites and outlines the measures needed to be taken for closure and rehabilitation of dumpsites. The guideline classifies the disposal sites based on several criteria like size, type of disposed waste and environmental conditions. The guideline introduces the 4 type of categories for the disposal sites based on environmental and health impact, as follows:

- Category I – no risk;
- Category II – low risk;
- Category III – medium risk;
- Category IV – high risk.

For closure and rehabilitation of different categories of dumpsites, the guideline suggests several types of activities depending of the size of dumpsite and estimated risk to environment and health, as follows:

- Closure by simply cover;
- Clean up before simple cover;
- Relocation.

Thus, once selected the type of measure for closure/rehabilitation of the dumpsite, it is important to choose the type of technical re-cultivation measure based on data regarding risk to underground water, risk to soil, quantities of gas to be generated and proximity to water source, inhabitant areas.

9.3 Schedule and cost estimation for closure

According the FS document, the new ISWM system for the WMZ 8 in NDR shall be established by the end of 2020 and become operational at the beginning of 2021.
The identified sites as TWDS cannot start immediately to act as transitional dumpsites and to accept larger amounts of waste from more localities, due to the fact that they need to be upgraded from technical and operational point of view, as mentioned in the section above. Also, it is needed to close the existing, non-compliant dumpsites in the project area, in the first wave of closure being included the dumpsites that pose a high risk to the environment and human health, then others. The assumption is that in 2018 it would be possible to get the transitional dumpsite operational.
The duration of closure activities will depend on the selected type of closure and would start when the new regional landfill is operational.
In order to carry out cost estimation, the disposal sites have been divided into the following categories:

- Non-compliant landfills with a capacity of more than 40,000 tones, which shall be maintained until the implementation of the integrated waste management system and closed in compliance with the provisions of Directive 1999/31/EC on the landfill of waste; The landfill capacities are calculated based on data about landfill start of operation, the number of residents living in the respective town or village and the unit generation rate per capita.
- Non-compliant landfills for which a simple closure is assumed (surface reduction, compaction and coverage with soil);
- Transitional waste disposal sites – for which a simple closure is assumed.

For all landfill sites with area less than 0.5 ha the possibility for relocation shall be considered and implemented in case of comparable closure costs. Relocation shall also be considered in case of high risk for the environment or human health identified during the risk assessment procedures.
The following unit costs have been considered for these categories of disposal sites:

- Closure of the non-compliant landfills in accordance with the provisions of Directive 1999/31/EC on the landfill of waste - an average cost of 163,000 EUR/ha
- Closure of the the transitional waste disposal sites – 20,000 EUR/ ha;
- Closure of the rural disposal sites, other than those specified above:
- 5,000 EUR/dumpsite in case the surface is ≤ 0.5 ha;
- 10,000 EUR/dumpsite in case the surface is > 0.5 ha.

The tables below present the estimation of the costs for the closure of the disposal sites in the three rayons: Donduseni, Briceni, Edinet and Ocnita.

In the tables, the disposal sites are grouped in terms of the estimated closure/ rehabilitation method.

Table 9-1: Cost estimation for closure of the existing disposal sites in Donduseni Rayon

Landfill	Start of operation	Area, ha	% occupied		Estimated closure costs
Donduseni	1975	5.000	75%	Closure according EU Directive	229,227
Arionesti	2012	1.500	35%	Transitional disposal site	20,000
Baraboi	1971	2.400	75%	Transitional disposal site	20,000
Criscauti	2011	0.500	40%	Transitional disposal site	20,000
Sudarca	2010	5.500	35%	Transitional disposal site	20,000
Arionesti	1992	1.000	35%	Simple cover	5,000
Cernoleuca	1960	2.000	100%	Simple cover	10,000
Cernoleuca	1960	1.750	100%	Simple cover	10,000
Plop	2000	1.000	2%	Simple cover/relocation	5,000
Plop	1999	1.100	2%	Simple cover/relocation	5,000
Pivniceni	2003	1.100	30%	Simple cover/relocation	5,000
Horodiste	2000	0.500	100%	Simple cover	10,000
Horodiste	2000	0.500	100%	Simple cover/relocation	10,000
Climauti	2000	0.500	50%	Simple cover/relocation	5,000
Corbu	1980	5.000	100%	Simple cover	10,000
Corbu	1970	6.000	100%	Simple cover	10,000
Criscauti	1992	1.000	70%	Simple cover	10,000
Elizavetovca	1995	1.100	50%	Simple cover	10,000
Elizavetovca	2000	1.000	50%	Simple cover	10,000
Elizavetovca	1998	1.300	50%	Simple cover	10,000
Frasin	1990	1.000	2%	Simple cover/relocation	5,000
Frasin	1990	0.500	2%	Simple cover/relocation	5,000
Sudarca	2010	1.500	50%	Simple cover	10,000
Mosana	1979	1.500	75%	Simple cover	10,000
Pocrovca	2014	0.400	35%	Simple cover/relocation	5,000
Pocrovca	2000	0.200	35%	Simple cover/relocation	5,000
Rediul Mare	2003	1.200	100%	Simple cover	10,000
Rediul Mare	2003	1.600	100%	Simple cover	10,000
Briceni sat	2010	0.400	50%	Simple cover/relocation	5,000
Donduseni sat	2000	1.300	75%	Simple cover	10,000
Scaieni	2001	1.000	75%	Simple cover	10,000
Scaieni	2000	2.500	75%	Simple cover	10,000
Țaul	1985	5.000	75%	Simple cover	10,000
Țaul	1980	3.000	80%	Simple cover	10,000
Tarnova	1995	1.000	50%	Simple cover	10,000
Tarnova	2000	1.300	50%	Simple cover	10,000
Tarnova	1990	1.200	50%	Simple cover	10,000
Tarnova	1980	0.900	50%	Simple cover/relocation	5,000
Teleseuca	2015	1.100	35%	Simple cover	5,000

Landfill	Start of operation	Area, ha	% occupied		Estimated closure costs
Total:					**589,227**

Source: GIZ/MSPL, Dumpsites database, Ministry of Environment

Table 9-2: Cost estimation for closure of the existing disposal sites in Briceni Rayon

Landfill	Start of operation	Area (ha)	% occupied	Assumed closure method	Estimated costs (EUR)
Briceni	2009	3.000	75%	Closure according EU Directive	110,029
Larga	1980	2.410	100%	Closure according EU Directive	157,137
Corjeuti	1988	3.400	50% - 75%	Closure according EU Directive	155,874
Lipcani	2008	5.200	<35%	Transitional disposal site	20,000
Tetcani	1999	1.000	100%	Transitional disposal site	20,000
Bogdanesti	1980	0.500	<35%	Transitional disposal site	20,000
Criva	2013	1.000	35% - 50%	Simple cover	10,000
Beleavinti	1997	1.000	75%	Simple cover	10,000
Colicauti	1992	2.300	70%	Simple cover	10,000
Hlina	2005	0.860	50%	Simple cover/relocation	5,000
Drepcauti	2007	0.350	100%	Simple cover/relocation	5,000
Marcauti	2000	1.000	80%	Simple cover	10,000
Marcauti	1998	1.000	75%	Simple cover	10,000
Sirauti	2000	0.500	50%	Simple cover/relocation	5,000
Slobozia Sirauti	1983	0.360	50%	Simple cover/relocation	5,000
Tabani	2000	1.400	20%	Simple cover/relocation	5,000
Trebisauti	1970	1.730	70%	Simple cover	10,000
Balcauti	2011	0.200	50%	Simple cover/relocation	5,000
Cotiujeni	2007	3.000	75%	Simple cover	10,000
Balasinesti	1982	1.100	40%	Simple cover	5,000
Bulboaca	1980	0.750	40%	Simple cover/relocation	5,000
Grimancauti	1980	3.000	100%	Simple cover	10,000
Halahora de Sus	2000	0.500	-	Simple cover/relocation	5,000
Berlinti	2003	1.300	100%	Simple cover	10,000
Mihaileni	1985	1.200	<35%	Simple cover	5,000
Caracusenii Vechi	2014	1.320	<35%	Simple cover	5,000
Caracusenii Vechi	1995	0.950	85%	Simple cover	10,000
Medveja	2012	0.600	<10%	Simple cover/relocation	5,000
Pererita	1992	2.500	70%	Simple cover	10,000
Coteala	2008	2.000	>75%	Simple cover	10,000
Total					**663,040**

Source: GIZ/MSPL, Dumpsites database, Ministry of Environment

Table 9-3: Cost estimation for closure of the existing disposal sites in Edinet Rayon

Landfill	Start of operation	Area (ha)		Assumed closure method	Estimated costs (EUR)
Edinet	1960	4.14	> 75%	Closure according EU Directive	379,599
Bratuseni 1	1975	5.00	100%	Closure according EU Directive	163,006
Cupcini	2015	2.30	< 35%	Transitional disposal site	20,000
Cepeleuti	2007	3.00	50%	Transitional disposal site	20,000

Stolniceni	1985	3.00	> 75%	Simple cover	20,000
Rotunda	2000	2.50	95%	Simple cover	10,000
Trinca	2000	1.00	20%	Simple cover	5,000
Sofrincani	2000	1.00	-	Simple cover	10,000
Fetesti	1990	0.87	50% - 75%	Simple cover	10,000
Badragii Vechi 1	2003	0.70	50%	Simple cover/relocation	5,000
Badragii Vechi 2	2003	0.25	50%	Simple cover/relocation	5,000
Badragii Noi	2007	1.85	1%	Simple cover	5,000
Bratuseni 2	1975	1.00	100%	Simple cover	10,000
Brinzeni 1	1995	1.20	85%	Simple cover	10,000
Brinzeni 2	1995	2.00	85%	Simple cover	10,000
Alexeevca	2003	4.00	< 35%	Simple cover	10,000
Gaspar	2001	5.00	35%	Simple cover	10,000
Terebna	1996	4.50	50% - 75%	Simple cover	10,000
Blesteni 1	2000	1.50	50% - 75%	Simple cover	10,000
Blesteni 2	2000	0.50	> 75%	Simple cover/relocation	5,000
Burlanesti	2011	1.48	< 35%	Simple cover	10,000
Cuconestii Noi	2000	2.00	-	Simple cover	10,000
Parcova	2000	1.50	40%	Simple cover	10,000
Parcova	2001	2.00	30%	Simple cover	10,000
Goleni	2000	-	-	Simple cover/relocation	10,000
Hancauţi	1990	1.50	50% - 75%	Simple cover	10,000
Ruseni	1980	1.80	< 35%	Simple cover	10,000
Constantinovca	2004	0.60	100%	Simple cover	10,000
Corpaci	1988	1.30	55%	Simple cover	10,000
Gordinesti	1970	2.00	75%	Simple cover	10,000
Hincauţi	2000	-	-	Simple cover/relocation	10,000
Lopatnic	1997	2.00	50%	Simple cover	10,000
Târnova	2000	3.00	80%	Simple cover	10,000
Viisoara	2000	-	-	Simple cover/relocation	10,000
Zabriceni	1978	1.50	60%	Simple cover	10,000
Zabriceni	1992	1.65	50%	Simple cover	10,000
Hlinaia	1999	0.80	-	Simple cover	5,000
Chetrosica Noua	1990	1.00	70%	Simple cover	10,000
Total					**902,605**

Source: GIZ/MSPL, Dumpsites database, Ministry of Environment

Table 9-4: Cost estimation for closure of the existing disposal sites in Ocnita Rayon

Landfill	Start of operation	Area (ha)	% occupied	Assumed closure method	Estimated costs (EUR)
Ocnita	2005	2.17	> 75%		198,969
Otaci	1956	2	100%		326,011
Birnova	2014	4.09	20%		10,000
Birladeni	1980	2	50%		10,000
Birladeni	1980	1	50%		10,000
Birladeni	1980	1	50%		10,000
Calarasovca	2000	-	-		10,000
Ocnita com.	2000	2	50%		10,000
Corestăuți	2007	1.5	30%		5,000
Frunze	2015	0.35	< 35%		5,000
Garbova	2003	0.8	50% - 75%		10,000
Grinăuți-Moldova	2003	1.5	30%		5,000
Grinăuți-Moldova	2000	0.4	45%		5,000
Grinăuți-Moldova	2004	0.5	50% - 75%		5,000

Landfill	Start of operation	Area (ha)	% occupied	Assumed closure method	Estimated costs (EUR)
Grinăuți-Moldova	2000	0.4	50% - 75%		5,000
Hadarauti	2006	2.5	100%		10,000
Lencauţi	1996	0.4	50%		5,000
Lencauţi	1996	0.4	85%		5,000
Lipnic	2003	2	30%		10,000
Lipnic	2010	1.2	50%		10,000
Mereseuca	1985	1	75%		10,000
Mihalașeni	2005	1.5	70%		10,000
Mihalașeni	2005	0.8	50%		5,000
Naslavcea	2000	0	0%		10,000
Sauca	2000	0.55	30%		5,000
Sauca	2000	11.9	12%		10,000
Unguri	2003	0.5	< 35%		5,000
Valcineț	2006	0.5	> 75%		5,000
Clocusna	1990	1	70%		10,000
Dingeni	2000	1	60%		10,000
Total					**744,980**

Source: GIZ/MSPL, Dumpsites database, Ministry of Environment

Within the identification process of the potential TWDS was done the estimation of the costs for the closure of the disposal sites in the four rayons: Donduseni, Briceni, Edinet and Ocnita. When doing costs calculation/estimation it was taken into consideration the closure/rehabilitation method, thus for closure of the existing disposal sites in above mentioned rayons is need for the following amount (EUR):

- Donduseni rayon – 589,000 EUR;
- Briceni rayon – 663,000 EUR;
- Edinet rayon – 903,000 EUR;
- Ocnita rayon – 745,000 EUR.

The total estimated cost for closure of existing disposal sites in the project area is about 2.9 million EUR.

10 Design parameters for the integrated waste management system

10.1 Collection and transport

This section describes the design parameters used for the recommended waste collection system in WMZ 8, including separate collection of waste.
The basic parameters which define the type of waste collection system are:

- Waste quantities and their composition;
- Number of households living in private houses;
- Desirability to extend the waste collection service to the entire population;
- Preferences for frequency of waste collection service to be provided to residents;
- Type of waste storage and collection equipment, like size, capacity, compaction ratio etc.;
- Physical planning parameters such as topography of the area, density of population, existing road network, natural protection areas, etc.;
- Targets for recycling and diversion of biodegradable waste from landfill.

The following table shows the quantities of municipal solid waste that need to be collected from the three rayons in WMZ 8 (in year 2021 as a reference year).

Table 10-1: Quantities and type of generated municipal solid waste, 2021

Waste type	Donduseni Rayon	Briceni Rayon	Edinet Rayon	Ocnita Rayon
Plastic	536	984	1,184	758
Paper & cardboard	501	917	1,133	722
Glass	350	649	717	464
Metal	175	322	391	250
Organic	2,268	4,189	4,808	3,097
Other	2,593	4,847	4,990	3,269
Total	6,423	11,907	13,223	8,560

Source: GIZ/MSPL

The table below presents the parameters used for defining the waste service cover.

Table 10-2: Parameters used for defining the waste service cover

Parameter	Unit	Value
Service cover (urban residents)	%	100
Service cover (rural residents)	%	100
Household waste in urban area	%	80.0
Similar[13] to household waste in urban area	%	20.0
Household waste in rural area	%	90.9

[13] The similar to household waste is defined as waste which has the characteristics of household waste. This waste is generated by commercial entities and institutions.

Parameter	Unit	Value
Similar to household waste in rural area	%	9.1

Source: GIZ/MSPL

As outlined in this report, the provision of waste management services will be organized at rayon level. Therefore, it is assumed that 100% service coverage of rural population is also feasible. Ultimately, all rural communities will benefit from a service which will be provided at lower cost compared to organisation of waste collection service by each community individually. The economy of scale could be achieved only if one operator provides the services in the respective rayon or if the entire WMZ 8 is served by one regional operator. The rayon or regional waste collection operator will have the flexibility to adjust the waste collection routes and ultimately to optimise the waste collection process. This will be done in cooperation with the local authorities, especially with regard to placement of the waste storage equipment.

Apart from the economic considerations, there are also other factors which make the provision of waste collection service to the entire rural population feasible. These are:

- The terrain of WMZ 8 is flat and there are no difficult to access villages;
- Almost all of the villages are located along the road network in the region;
- Most of the villages are large. Out of 95 villages only 1 village have population of less than 500 residents.

10.1.1 Collection and transport of residual waste

The following assumptions are used to determine the waste collection and transport equipment needed to cover the entire population of the project area.

Table 10-3: Assumptions for assessment of waste collection and transport needs

Equipment	Assumption	Unit	Value
Containers (1.1 m^3)	Frequency of serving per year (urban blocks)	№	104
	Frequency of serving per year (villages)	№	52
	Density in container	t/m^3	0.18
	Container volume	m^3	1.10
	Average filling of container	%	85%
	Irregularity coefficient[14]		1.3
	Average waste per container	tonne	0.122
	Reserve (containers)	%	5%
Bins (120 l)	Frequency of serving per year (urban houses)	№	52
	Density in container	t/m^3	0.18
	Container volume	m^3	0.12
	Average filling of container	%	80%
	Irregularity coefficient		1.3

[14] Represents the ration between the maximum and the average weekly amounts

Equipment	Assumption	Unit	Value
	Waste per container	tonne	0.013
	Reserve (containers)	%	5%
Trucks	Capacity of collection truck	m^3	16
	Capacity of collection truck	m^3	10
	Compaction	m^3/tonne	0.5
	Degree of truck filling	%	85%
	Availability of truck	%	90%
	Average speed	km/h	35
	Time for loading container (urban)	min	1.0
	Time for loading container (villages)	min	1.5
	Time for loading bins (villages)	min	0.42
	Number of working days	№	260
	Number of working shifts	№	1
	Days of waste collection/week	№	5
	Effective working hours per shift[15]	№	8

Source: GIZ/MSPL

Based on the distances to the future regional landfill and the transfer stations respectively, calculations are made with regard to the time needed for a single collection trip and the number of trips per day needed.

The tables below show the design parameters of the system for collection and transport of residual waste. The transport equipment includes only the equipment which will be used to transport the collected waste to the transfer stations or directly to the regional facility and not the equipment needed to transport the waste from the transfer stations. The equipment needed also takes into consideration the existing containers and trucks, which can be utilised in the new system.

Table 10-4: Design parameters of the system for collection of residual waste[16], 2021

Description	Container type	Number
Donduseni urban (block of flats)	1.1 m^3	43
Donduseni urban (houses)	120 l	1,121
Donduseni rural	1.1 m^3	693
Briceni town (block of flats)	1.1 m^3	89
Briceni town (houses)	120 l	1,680
Briceni rural	1.1 m^3	1,317

[15] 10 m^3 collection vehicles serving 50% of rural areas in Ocnita rayon operate in 12 hours shift for cost optimization purposes.

[16] The existing collection equipment (containers, bins) purchased after 2014 taken into account

Description	Container type	Number
Edinet town (block of flats)	1.1 m^3	6
Edinet town (houses)	120 l	2,170
Edinet rural	1.1 m^3	572
Ocnita town (block of flats)	1.1 m^3	6
Ocnita (houses)	120 l	2,226
Ocnita rural	1.1 m^3	567
Total containers needed (1.1 m^3)	1.1 m^3	3,292
Total containers needed (120 l bins)	120 l	7,197

Source: GIZ/MSPL

Table 10-5: Design parameters of the system for transport of residual waste, 2021

Description	Unit	Truck type	Value
Donduseni (blocks of flats, 50% container sites rural)	№	16 m^3	1
Donduseni (urban houses, 50% container sites rural)	№	10 m^3	2
Briceni (blocks of flats, 75% container sites rural)	№	16 m^3	3
Briceni (urban houses, 25% container sites rural)	№	10 m^3	2
Edinet (blocks of flats, 70% container sites rural)	№	16 m^3	2
Edinet (urban houses, 30% container sites rural)	№	10 m^3	2
Ocnita (blocks of flats, 50% container sites rural)	№	16 m^3	2
Ocnita (urban houses, 50% container sites rural)	№	10 m^3	2
Total WMZ 8 trucks needed	№	16 m^3	8
Total WMZ 8 trucks needed	№	10 m^3	8

Source: GIZ/MSPL

In order to estimate both the investment and operation and maintenance costs, the following assumptions are used, as presented in the tables below.

Table 10-6: Assumptions for the investment costs

Equipment	Type	Unit	Unit price
Containers (metal)	1.1 m^3	EUR	320
Bins	120 l	EUR	30
Trucks	16 m^3	EUR	130,000
Trucks	10 m^3	EUR	92,000

Source: GIZ/MSPL

The investments for construction of container sites are not taken into account in the developed cost estimates.

Table 10-7: Assumptions for the operation and maintenance costs, 2021

Description	Unit	Unit value
Economic growth	%	2
Drivers salary	€/year	3,247
Loaders salary	€/year	2,706
Collection supervisors salary	€/year	4,330
Head of section salary	€/year	4,546
Mechanics salary	€/year	3,139
Price of fuel	€/liter	0.93
Oil	% of fuel cost	10
Maintenance trucks	% of investment cost	5
Maintenance containers	% of investment cost	2
Unscheduled service	% of annual costs	5
Insurance	% of investment costs	1
Administration	% of operating costs	10

Source: GIZ/MSPL

The investment costs for collection and transport of residual waste are shown in section 11.2. The operation and maintenance costs are presented in section 11.3

10.1.2 Collection and transport of separately collected recyclables

Separate waste collection will be organised in all settlemets of WMZ 8. The separate collection will be implemented through 'bring system' using three coloured plastic 1.1 m^3 containers – one for paper and cardboard, one for plastic and metals and one for glass. The following assumptions are used to determine the equipment needed for separate collection and transport of recyclables to cover the urban settlements in the project area taking into consideration the existing equipment which can be utilised by the new system.

Table 10-8: Assumptions for assessment of separate waste collection and transport needs

Assumption	Unit	Value
Frequency of serving per year (paper and cardboard, plastic)	№	52
Frequency of serving per year (glass)	№	12
Density in container (paper and cardboard)	t/m^3	0.14
Density in container (plastic and metals)	t/ m^3	0.09
Density in container (glass)	t/ m^3	0.29
Container volume	m^3	1.10
Average filling of container	%	70%
Irregularity coefficient	%	1.4
Reserve (containers)	%	5%

Assumption	Unit	Value
Frequency of serving per year	№	26
Capacity of collection truck	m^3	16
Average pay load collection truck	tonne	6.8
Average speed	km/h	35
Time for loading container	min	2.0
Number of working days	№	260
Number of working shifts	№	1
Days of waste collection/week	№	5
Effective working hours per shift	№	8

Source: GIZ/MSPL

The tables below show the design parameters of the system for separate collection and transport of recyclable waste.

Table 10-9: Design parameters of the system for separate collection of recyclables, 2021

Containers	Location/rayon	№ of containers
Containers for paper and cardboard plastic)	Donduseni	82
	Briceni	148
	Edinet	180
	Ocnita	115
Containers for plastic and metal	Donduseni	82
	Briceni	149
	Edinet	181
	Ocnita	115
Containers for glass	Donduseni	81
	Briceni	150
	Edinet	166
	Ocnita	107
Total containers needed		**1,555**

Source: GIZ/MSPL

The unit costs for plastic 1.1 m^3 containers for separate collection of paper and cardboard are 150 €/pcs and 320 €/pcs for the containers used for separate collection of glass.

Table 10-10: Design parameters of the system for transport of recyclables, 2021

Equipment	Type	Required	To be purchased

Equipment	Type	Required	To be purchased
Separate waste collection vehicles (Donduseni)	16 m^3	0.3	0
Separate waste collection vehicles (Briceni)	16 m^3	0.5	0
Separate waste collection vehicles (Edinet)	16 m^3	0.5	1
Separate waste collection vehicles (Ocnita)	16 m^3	0.4	0

Source: GIZ/MSPL

The project does not envisage purchasing of specialized vehicles for separate waste collection, except for Edinet. The service will be provided through the same trucks used for the residual waste collection.

T

he assumptions used for the estimate of operating costs are presented in the table below.

Table 10-11: Assumptions for the operation and maintenance costs, 2021

Description	Unit	Unit value
Economic growth	%	2
Drivers salary	€/year	3,247
Loaders salary	€/year	2,706
Collection supervisors salary	€/year	4,330
Head of section salary	€/year	4,546
Mechanics salary	€/year	3,139
Price of fuel	€/liter	0.93
Oil	% of fuel cost	10
Maintenance trucks	% of investment cost	5
Maintenance containers	% of investment cost	2
Public awareness	% of annual costs	10
Insurance	% of investment costs	4
Administration	% of operating costs	10

Source: GIZ/MSPL

The investment costs for collection and transport of recyclables are shown in section 11.2. The operation and maintenance costs are presented in section 11.3.

The table below shows the quantity of recyclables expected to be collected by the system for separate collection and the amount of sorted materials[17].

Table 10-12: Quantity of collected recyclables and quantity of sort, 2021

[17] The difference between the recyclables collected and the amount of sorted materials presents the impurities in separately collected waste.

Material	Unit	Amount collected	Amount sorted
Paper and cardboard	tonne	1,329	1,139
Plastics	tonne	866	742
Glass	tonne	921	789
Metals	tonne	481	413
Total recyclables collected	tonne	**3,597**	**3,082**

Source: GIZ/MSPL

The assumed existing market prices for recyclables and the expected revenue from sale of recyclables are presented in the table below.

Table 10-13: Revenue from sale of recyclables, 2021

Material	Unit price	Sorted recyclables	Revenue estimate
	€	tonne	€
Paper and cardboard	75.00	1,139	85,000
Plastics	220.00	742	163,000
Glass	10.00	789	8,000
Metals	280.00	413	116,000
Total		**3,082**	**372,000**

Source: GIZ/MSPL

10.1.3 Collection of construction and demolition waste

The collection of construction and demolition waste (CDW) and bulky waste will be organized on-demand and full cost recovery basis. The residents will contact the local authority or operator and request such a service.

In addition, the transfer stations in Niscani and Edinet and the regional landfill in Donduseni will have designated areas and equipment for temporary storage of construction and demolition waste (CDW) as well as bulky waste. Residents of WMZ 8 will have the possibility to bring their CDW directly to any of the three drop-off centres, free of charge. This could be done during the opening hours of the three facilities.

The service operators in each of the rayons will be provided with limited number of roll-on containers for on-demand collection of CDW.

No additional investment in specialized collection vehicles will be required as the existing equipment could be utilised for this service.

10.2 Transfer stations

10.2.1 Design criteria

In WMZ 8 two transfer stations are needed in Briceni and Edinet Rayons, since all waste from these Rayons will be transported to the new regional landfill in Donduseni. The capacity of the transfer station shall be sufficient to handle all waste collected in the respective Rayon.

The maximum amount of waste delivered to the sites in 2021 will be 11,684 t (Edinet) and 11,245 (Briceni). The basic design idea is to have a reliable and affordable system, which is easy to manage. Since the daily amounts with maximum 45 t/day (assuming 250 working days) are rather small, a long distance transportation without compaction has been selected using hook lifter trucks with trailer transporting 40 m^3 container as shown in

Figure 10-1. The load capacity of truck and trailer is 22 t per trip (maximum gross weight of the road train), which translates into a maximum density in the container of 275 kg/m^3. This density can be reached without external compaction.

Figure 10-1: Long distance transportation truck

Source: GIZ/MSPL, Infrastruktur & Umwelt

The travel distance to the landfill is 43 km (Edinet) and 75 km (Briceni) with max travel time of 1.5 hours, which allows basically 2 trips per day keeping Saturdays as a contingency. The total waste amount delivered per day to the transfer stations fits into 4 containers. As a reserve a fifth container is placed. Since two long distance trucks are available in the zone, severe car breakdowns may be compensated. The storage capacity on site lasts for 1.25 days. Longer lasting truck breakdowns can only be mitigated by direct transportation to the landfill by the collection trucks. A reserve truck to cover up potential breakdowns is not reasonable.

10.2.2 Site descriptions

Briceni

The transfer station for the Briceni Rayon shall be established at an abandoned industrial area west of Briceni town (

Figure 10-2 and Source: *GIZ/MSPL*

Figure 10-3). The selected site on the premises of the former industrial area is located at the western edge of the area.

Figure 10-2: Location of future transfer station Briceni

Source: GIZ/MSPL

Figure 10-3: Site view of future transfer station Briceni

Source: GIZ/MSPL, Kölsch

The soil conditions on site have been investigated by geotechnical company INGEOCAD. A separate report on the geotechnical testing is available. INGEOCAD stated generally "conventionally favourable conditions for construction". The geotechnical investigation obtained in the designated area two different layers, one layer loam (3 m) on top of a layer clay (9 m). The major soil properties are:

- Shear strength: angle of internal friction φ = 25°, cohesion 29 kPa (loam)
- angle of internal friction φ = 21°, cohesion 41 kPa (clay)
- Density (natural) ρ = 1.99 t/m^3 (loam), 2.12 t/m^3 (clay)
- Compressibility E = 23 MPa (loam), 21 MPa (clay)

Those properties indicate suitable subsoil conditions for lighter constructions (small civil structures, rigid areas etc.). In some areas soil replacement as an improvement for the foundations may be needed.

Edinet

The transfer station for the Edinet Rayon shall be established at a pasture land plot 4 km North-West of Edinet town (Figure 10-4). The site will host a combined facility consisting of a transfer station and a sorting station (MRF).

The soil conditions on site have been investigated by geotechnical company INGEOCAD. A separate report on the geotechnical testing is available. INGEOCAD stated generally "conventionally favourable conditions for construction". The geotechnical investigation obtained in the designated area below the 0.5 m top soil a 1 m layer of loam followed by up to 12 m clay. The major soil properties are:

- Shear strength: angle of internal friction φ = 25°, cohesion 29 kPa (loam)
- angle of internal friction φ = 21-23°, cohesion 34-46 kPa (clay)
- Density (natural) ρ = 2.00 t/m^3 (loam), 2.06-2.12 t/m^3 (clay)
- Compressibility E = 21 MPa (loam), 17-23 MPa (clay)

Those properties indicate suitable subsoil conditions for lighter constructions (small civil structures, rigid areas etc.). In some areas soil replacement as an improvement for the foundations may be needed.

Figure 10-4: Location of future transfer station Edinet

Source: GIZ/MSPL

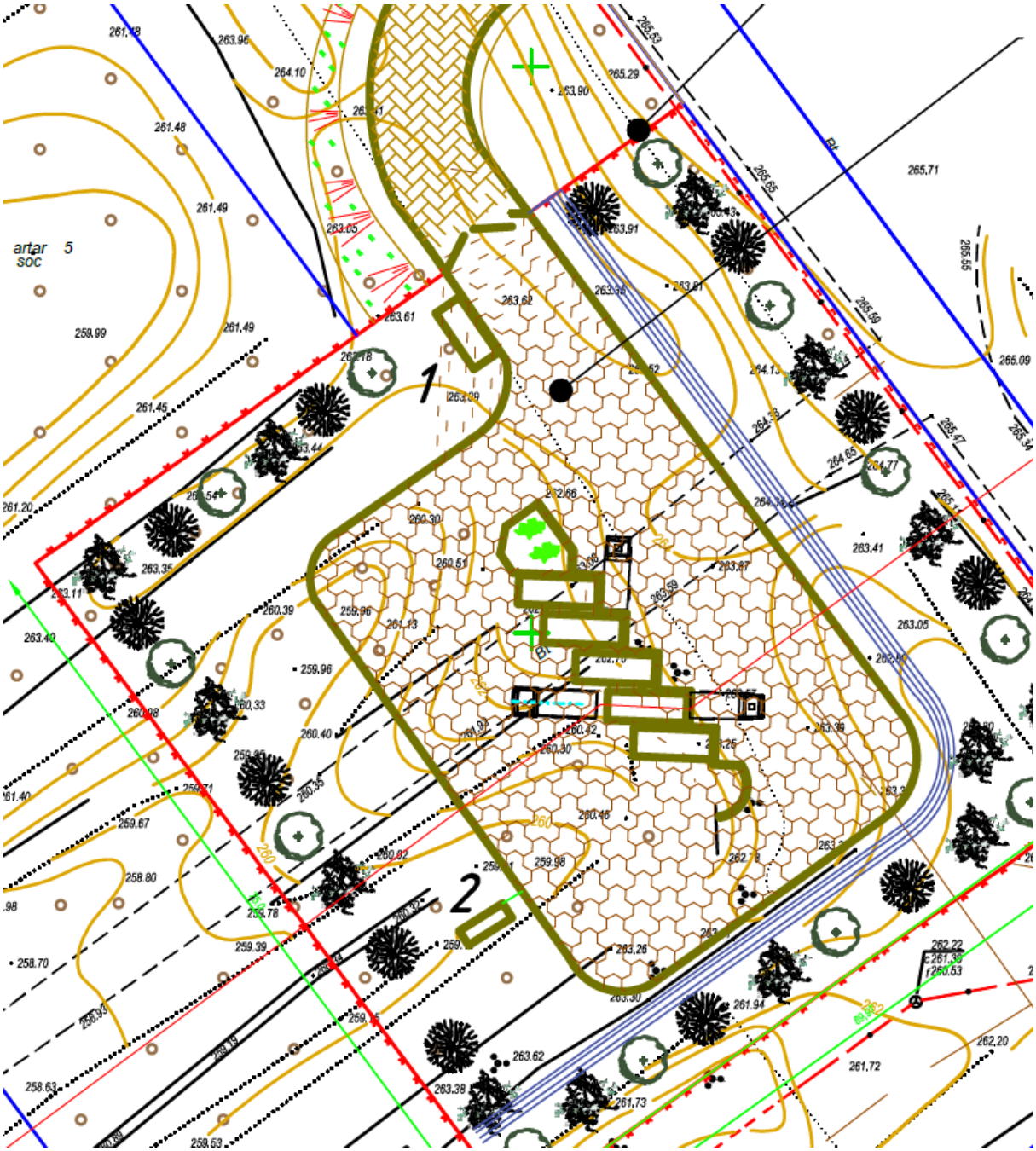
10.2.3 Lay out and equipment of transfer station

The transfer stations will consist of:

- 2 level transfer ramp
- 5 slots for 40 m^3 long distance transportation container (roofed)
- access road to both levels for the collection trucks (upper) and the long distance trucks (lower)
- entrance area with improved existing office building and weighbridge.

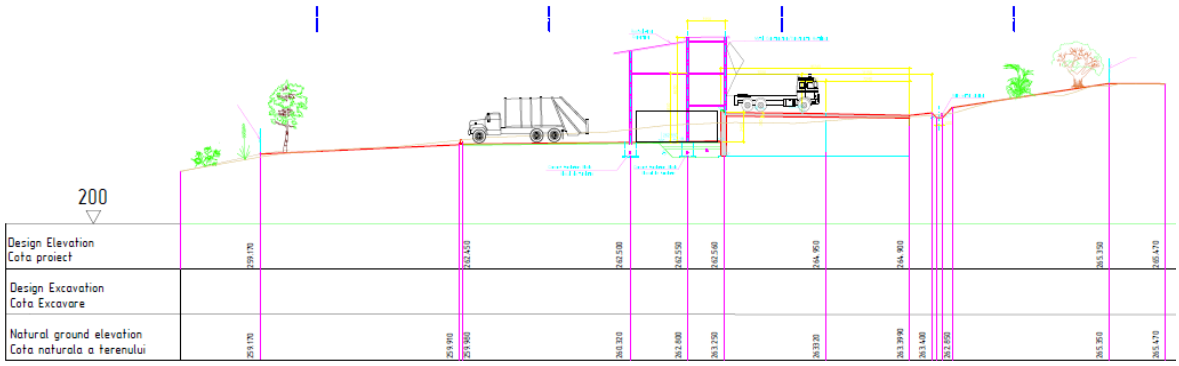
The layout of the planned transfer stations is presented in
Figure 10-5 (ground map) and Figure 10-6 (cross section) by example of TS Briceni. The lay out of the combined facility in Edinet can be found in chapter 10.3, detailed drawings are presented in the **Annex 11.**

Figure 10-5: Future transfer station Briceni - site map



Source: GIZ/MSPL

Figure 10-6: Future transfer station Briceni - cross-section A-A



Source: GIZ/MSPL

Figure 10-7 shows an example for the selected type of simple 2-level transfer station. The transfer station area will be completely asphalted. Areas for container handling (roll-on/roll-off) will be equipped with concrete structure. All incoming waste deliveries will be weighed and registered. For this purpose a weigh-bridge for trucks of 8x3 m (measuring capacity 40 tonnes) will be installed at the entrance of the site. Directly next to the weighbridge, a small weighing office will be constructed. The weighing operator has visual contact to the truck driver and the possibility of a visual inspection of the truck load by using a mirror, outside installed at a mast. The weighing office is equipped with a computer and special weighing software to collect all data such as the type, characteristics, weight, the origin of the waste, name and address of deliverer and the precise location where the waste has been collected. Trucks with residual waste for transfer to the landfill in Donduseni, separately collected recyclables for the waste sorting plant in Edinet and green waste for composting located at Donduseni landfill will be directed here and sent to their destination point. A prefabricated office container (5 x 2.5 m) will be used. It will be equipped with illumination, heating and cooling system and a toilet. Foundations will be constructed in accordance with the requirements of the supplier.

Figure 10-7: Example for 2 level simple transfer station

Source: GIZ/MSPL, *GOPA*

Social rooms for the staff are provided inside the existing administration building (Edinet) and in the office container (Briceni) respectively. Inside the buildings storage area is available for tools and smaller equipment. Six fire extinguishers will be placed in the office container/ administration building and at the transfer ramp.

Waste delivery is done during the early evening hours as well. Hence lighting of the reception area must be ensured. It is recommended to install 150 W reflectors on lamp-posts beside the roads and the platform. The value of the overall lighting should be 80 lux.

The transfer station will be surrounded by a fence of minimum 2.50 m height. The gate at the access is opened only during the opening times of transfer station. The fence is necessary to

avoid unpermitted access of people, irregular waste dumping and to hinder bigger animals from entering the area.

10.2.4 Utilities and staff requirements

The electricity supply of the transfer station can be covered by the existing power supply for the sorting facility (Edinet). In Briceni, electricity supply is available at the premises of the former industrial compound. Same applies to the water supply.

Surface water from the access road and the platforms of the transfer station will be directed to road trenches for infiltration.

Waste water from administration building will be treated in a double chamber waste water treatment plant.

For transfer station operation (including the long distance transportation) 5 staff are needed, 1 foreman to supervise the operation, 2 unskilled workers for simple activities at the platforms (cleaning, sweeping, minor reparations) and 2 drivers for the long distance trucks.

10.3 Sorting plants

10.3.1 Design criteria

Plastic, paper, cardboard and metals are collected in separate bins in the WMZ 8. The separately collected materials will be transported to the future sorting plant in Edinet, either via the transfer station (Briceni), directly (Ocnita, Edinet) or via a transfer platform at Donduseni landfill (Donduseni).

At the sorting station in Edinet the pre-sorted materials will be sorted in the fractions:

- Paper
- Cardboard
- Metal
- Green plastic bottles and similar
- White plastic bottles and similar
- Other plastics.

The sorting procedure will consist of the following steps:

- The recyclables will be delivered to the sorting plant Edinet and stored in a designated reception area for further processing. A wheel loader will fill the recyclables in a feeding bunker from where they are transported via a conveyor to a sorting flat belt for manual sorting of the above mentioned fractions. The workers at the sorting belt select and throw the materials into big bags or plastic bins placed next to the sorting belt. Residues remain on the belt and will be transported further ending up in a waste container at the upper end of the belt. The residues will be transported to the transfer station for further transport to Donduseni landfill for disposal;
- The sorted materials in the bags and bins will be transported to a baler to reduce the transport volume;

- Afterwards the baled recycling materials will be stored inside the sorting hall or outside under the roof to be picked up by the traders.

Based on the calculations for the separate collection systems 4,000 t/year of recyclables are expected:

10.3.2 Site description

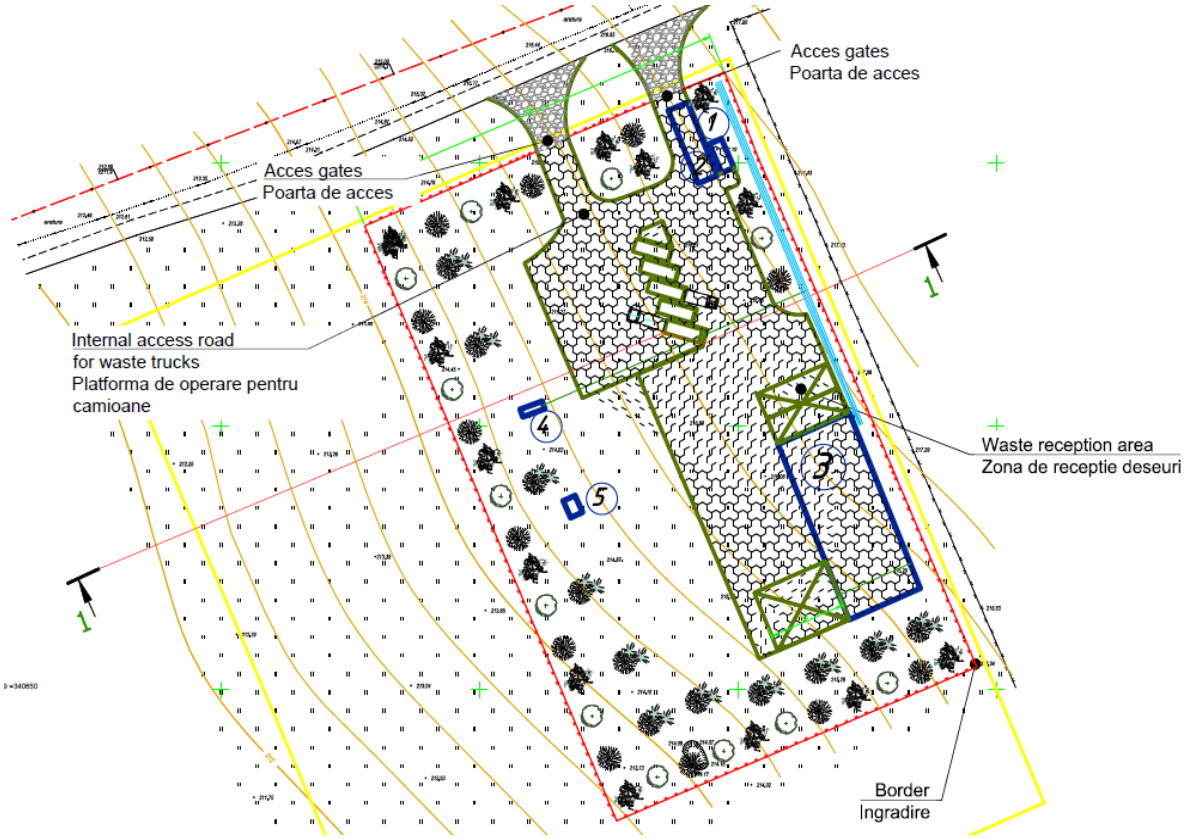
The sorting plant for the WMZ 8 shall be established at the premises of the transfer station in Edinet (chapter 10.2.2).

10.3.3 Layout and equipment of sorting plant

For the lay out of the facility it was assumed, that one worker can handle about 200 kg of incoming recyclables (including residues) per hour. Assuming daily net working time of 6.5 hours (including breaks and other interruptions) the daily amount for hand sorting will be 1.3 t of recyclables. Thus, in sorting plant Edinet 12 workers are needed. The sorting plants will be operated 5 days a week (Monday –Friday) respectively 260 days per year with one shift of 8h hours per day (gross working time). Increasing amounts of recyclables can be handled by adding more shifts. The facility features one sorting flat belt with a length of 12 m. A small drum sieve is placed in front of the sorting belt in order to loose compacted materials and to segregate useless small particles. The the drum sieve is fed via a conveyor which transports the materials from the outside flat bunker to the sorting area. The sorting belt, baler and some storage are placed in a closed hall with dimensions of 36 x 15 m. The bunker for the delivered recyclables is placed in front of the hall and has a size of 30 m^2. The roofed area for storage of baled and sorted recyclables is 15 x 12 m (180 m^2). Additional open air storage areas are available next to the building. The following figures illustrate the lay out of the sorting plant Edinet.

Figure 10-8 shows the site map for the combined sorting plant and transfer station. All drawings can also be found in the **Annex 11**.

Figure 10-8: Future sorting plant Edinet - site map



Source: GIZ/MSPL

Figure 10-9, Source: *GIZ/MSPL*

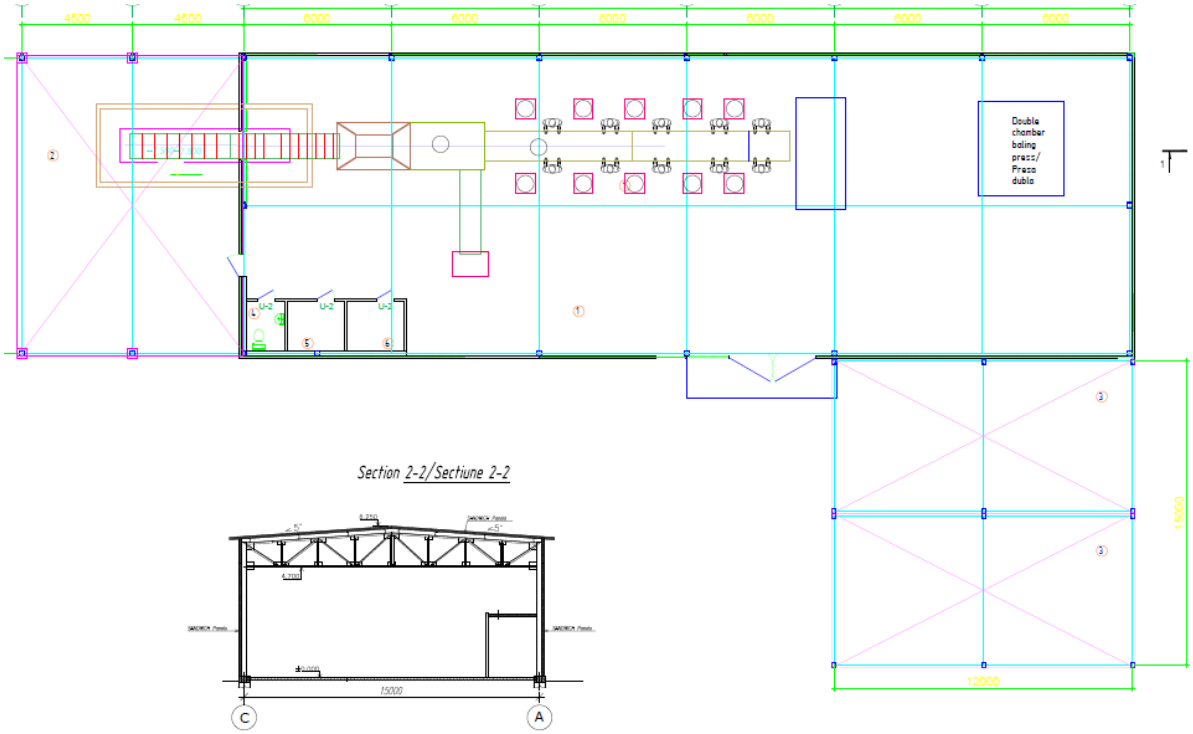
Figure 10-10 and Source: *GIZ/MSPL*

Figure 10-11 illustrate the ground plan and the cross sections of the sorting plant Edinet. In the ground map the elements are (from left to right): roof of delivery area, flat bunker, inclined conveyor belt, feed hopper and drum screen, discharge small particles, sorting flat belt and

working places (not fully staffed), bags and bins for recyclables, container for residuals left on the belt, double chamber baler, roofed area for baled and sorted recyclables.
Source: *GIZ/MSPL*

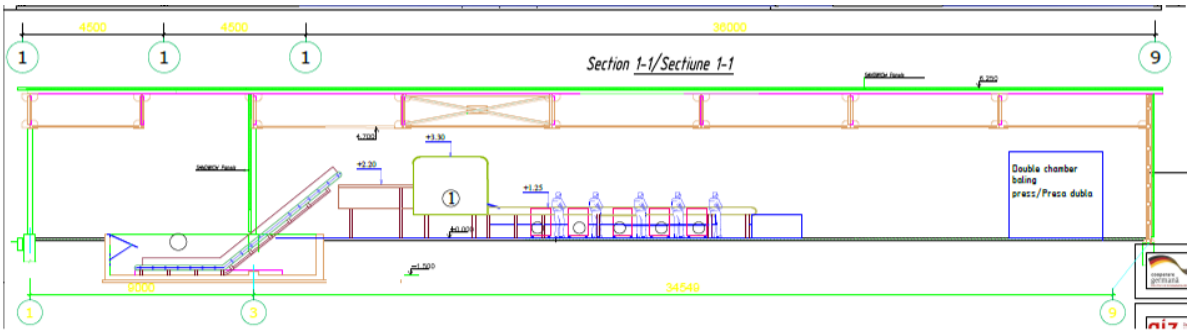
Figure 10-12 shows a practical example of the proposed equipment in an open, roofed facility.

Figure 10-9: Future sorting plant Edinet- ground plan



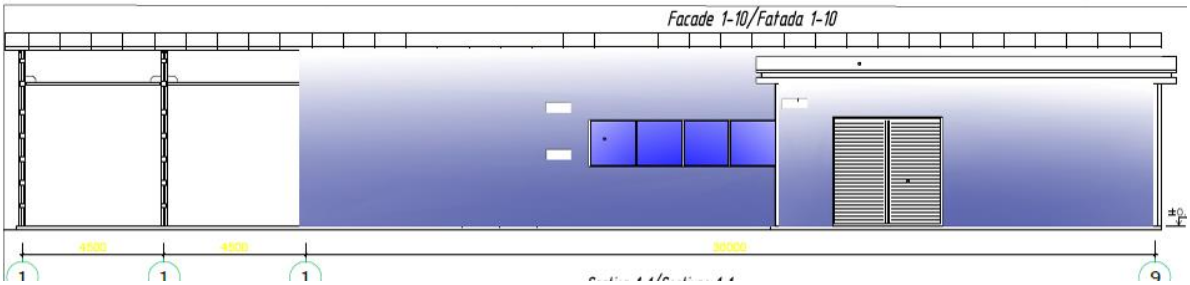
Source: GIZ/MSPL

Figure 10-10: Future sorting plant Edinet - cross section (longitudinal)



Source: GIZ/MSPL

Figure 10-11: Future sorting plant Edinet- cross section (facade)



Source: GIZ/MSPL

Figure 10-12: Example for equipment of sorting station

Source: GIZ/MSPL, Kölsch

The baling will be carried out in a double chamber automatic baler. Figure 10-13 shows a double chamber baler as proposed.

Figure 10-13: Example for double chamber baler

Source: GIZ/MSPL, MTB Reichel

The baler produces bales of 200 kg each with dimensions 1 x 1 x 0.8 m (H x W x D). The pressing force is up to 16 tonnes. The pressing time is 34 seconds. Both chambers can be operated in parallel sharing the hydraulic jack. The capacity is about 2.5 tonnes per hour assuming loading times of 5 minutes. Thus, the baler capacity is more than sufficient. The bales will be moved by using fork lifter.

10.3.4 Utilities and staff requirements

The electricity demand for the sorting plant facility adds up to roughly 18 kW. The water demand is small, because water is required for cleaning and personal use, only. All public supplies (water, electricity) need to be newly established, since it is an undeveloped, virgin area. The appropriate configuration needs to be clarified with the service providers.

Surface water from the paved areas around the sorting building will be directed to side trenches for infiltration.

Waste water from social rooms inside the sorting building will be treated in a double chamber waste water treatment plant.

For the operation of the sorting plant Edinet 17 staff are needed, beside the 12 unskilled sorters 1 facility manager (who is also in charge with the transfer station), 1 foreman to supervise the operation, 1 skilled worker (maintenance), 1 unskilled worker (baler) and 1 driver (wheel loader), who is also working for the transfer station.

10.4 Composting plant

10.4.1 Design criteria

As described in section 8, green waste will be collected separately from public green areas in the 4 Rayons. The total amount adds up to 942 t/year. This amount is comparably small and does not justify establishing an advanced composting plant. However, a simple composting pad shall be established at the landfill site in Donduseni. The plant can be seen as a pilot approach introducing the composting process to the region.

The design value for the treatment capacity is 1,000 tonnes/year. Various treatment techniques are available which vary in terms of required treatment time, space and costs. The overall situation in the region is characterized by the fact that space and time is available while financial resources are limited. Due to this and since the plant is small a simple open passively aerated windrow composting with static piles and regular windrow turning has been selected.

The total area needed for the composting pad using the chosen process is 28.8 x 41.7 m = 1,200 m^2 with a length of each windrow of 36.7 m (turning of the tractor with compost turner only on the head side). The 28.8 m width of the pad provides space for 3 twin windrows with 2.8 m bottom width each. Between the twin windrows is one manoeuvring line for the tractor (width: 3 m) plus additional one lane on the left and right side. In total 4 lanes are needed (the tractor turns on the left and on the way back on the right side). Between the 4 manoeuvring lanes 6 windrows can be placed. The total length adds up to 6 x 36.7 m = 220 m. With a windrow cross sectional area of 2.66 m^2/m the total windrow volume arrives at 583 m^3. The placement density is expected to be 0.4 t/m^3 which translates into 583 m^3 x 0.4 = 233 t per batch. Assuming 12 weeks treatment period 4.3 batches per year can be processed which equals to 4.3 x 233 t = 1,012 t/year.

Figure 10-14: An example of a windrow composting facility

Source: GIZ/MSPL, *http://www.bae.uky.edu/uk-arc/composting.htm*.

The composting plant shall feature the following components: 1) waste receiving area; 2) windrow treatment area (concrete pad); 3) leachate/storm-water discharge, 4) sieving, shredding and storage area. An example of such a facility is presented in

Figure 10-14.

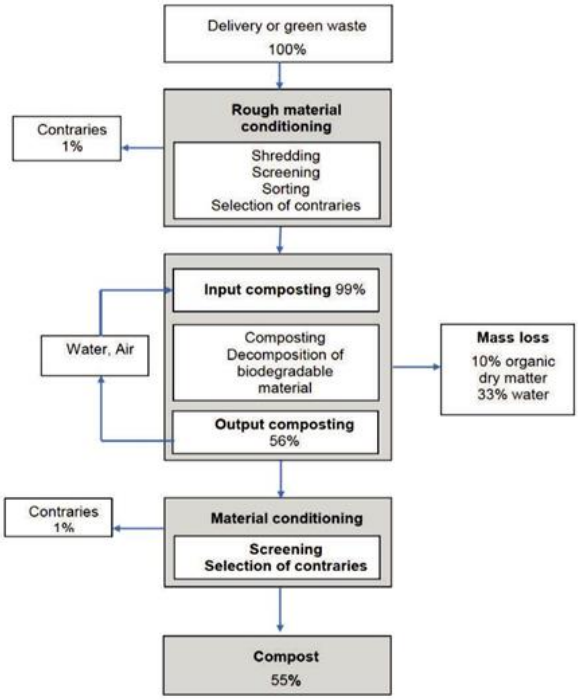
10.4.2 Site and process description

One composting plant will be established in WMZ 8 at the future landfill Donduseni. The site map and detailed site description is presented in chapter 10.5.

Composting is an aerobe treatment process. Organic components of the input material will be decomposed by microorganisms and thus stabilized. Nutrients such as nitrogen (N), phosphate (P) and Potassium (K) remain in the final product and make the compost a valuable source of fertilizer. The process flow sheet of the compost plant is shown in

Figure 10-15. The input material will be conditioned by means of segregating impurities and bulky materials (grain size >500 mm). The input fraction >500 mm will be shredded.

Figure 10-15: Composting process flow sheet



Source: GIZ/MSPL

The primary composting (intensive rotting) will take place over a period of 12 weeks days, before the will be screened and allowed to mature. The final compost product can be used either as fresh compost (without maturation) or matured compost. The rejects of the screening process will be redirected to the composting process, where it acts as structural material in new composting windrows. In order to supply sufficient oxygen to the microorganisms and to cool down the heaps during intensive treatment phase the windrows will be frequently turned using a windrow turner as shown in

Figure 10-16. During the treatment certain water content in the windrows needs to be maintained. In cool and humid climate the treatment is carried out partly under roof to avoid a breakdown of the biological process due to wetting. Same applies for tropical climate with extreme heavy precipitation of 30 mm/h and more. The climate conditions in Moldova are favorable and allow running the process open air, since larger precipitation (40+ mm) occurs in summer time (April to September), when the daily average high temperature is mostly above 20°C.

During that time the evaporation is high, hence the windrows will quickly loose moisture. During that period irrigation of the windrows will be required. Irrigation water can be taken from the maturation basin of the leachate treatment plant, since the remaining concentrations will be low and will not contaminate the final compost product. Excess water during wet periods are captured and directed to the leachate pond.

Figure 10-16: Windrow turner

Source: GIZ/MSPL, *http://www.gujerinnotec.com*

10.4.3 Layout and equipment of the composting plant

The treatment area is 1,200 m^2. The entire area shall be constructed by asphalt or concrete ground. Optionally, half of the treatment area could be constructed using mineral concrete ("savura"), a 0-15 mm limestone material which forms a rigid ground after compaction. The location of the treatment area is shown in the lay out plan for the landfill. Beside the side windrow turner and the tractor for pulling the turner (

Figure 10-16), the major equipment consists of a mobile shredder and a mobile compost screen (Figure 10-17).

Figure 10-17: Composting plant - screen (left), shredder (right)

Source: GIZ/MSPL, Kölsch

10.4.4 Utilities and staff requirements

The plant does not require fixed public supplies, because it is part of the future landfill site. The water demand for irrigation will be provided by means of a tractor pulled tank trailer which is filled at the maturation basin of the landfill leachate treatment plant. Leachate from the composting pad is directed to the landfill leachate collection system.

For the operation of the composting plant two additional staff are needed, 1 trained worker, who supervises the biological process by doing temperature measurements and 1 unskilled worker, who supports operating the shredder and the screen. Drivers and other staff will be provided by the landfill operation.

10.5 Landfill

10.5.1 Design criteria

The future landfill for WMZ 8 shall provide sufficient airspace to receive the waste from the service area for a period of up to 20 years.

Table 10-14 lists the projected waste amounts for the service region with the Rayons Ocnita, Donduseni, Edinet and Briceni assuming the start of operation of the new landfill in 2021. The total amount is estimated to 598,651 tonnes for a 20 year period.

Table 10-14: Projected waste amounts for disposal starting 2021

Year:	2021	2023	2026	2029	2031	2036	2040
Waste amount [tonnes]	35,137	34,009	32,867	31,660	31,076	29,741	28,767
Waste amount [cumulated t]	35,137	103,919	203,666	299,849	362,290	513,575	630,088

Source: GIZ/MSPL

Assuming a compacted waste density of 1 t/m^3 the required total landfill airspace is about 650,000 m^3. The landfill shall be constructed in three phases (cell 1-3) with cell 1 constructed as initial investment. The cells will be designed in a way that the construction efforts (and investments) are equally divided.

Regarding the technical features of the facility the main design criteria were:

- Application of adequate technical standards to match the overall protection goals of modern landfilling, in particular redundant (combined) barrier system

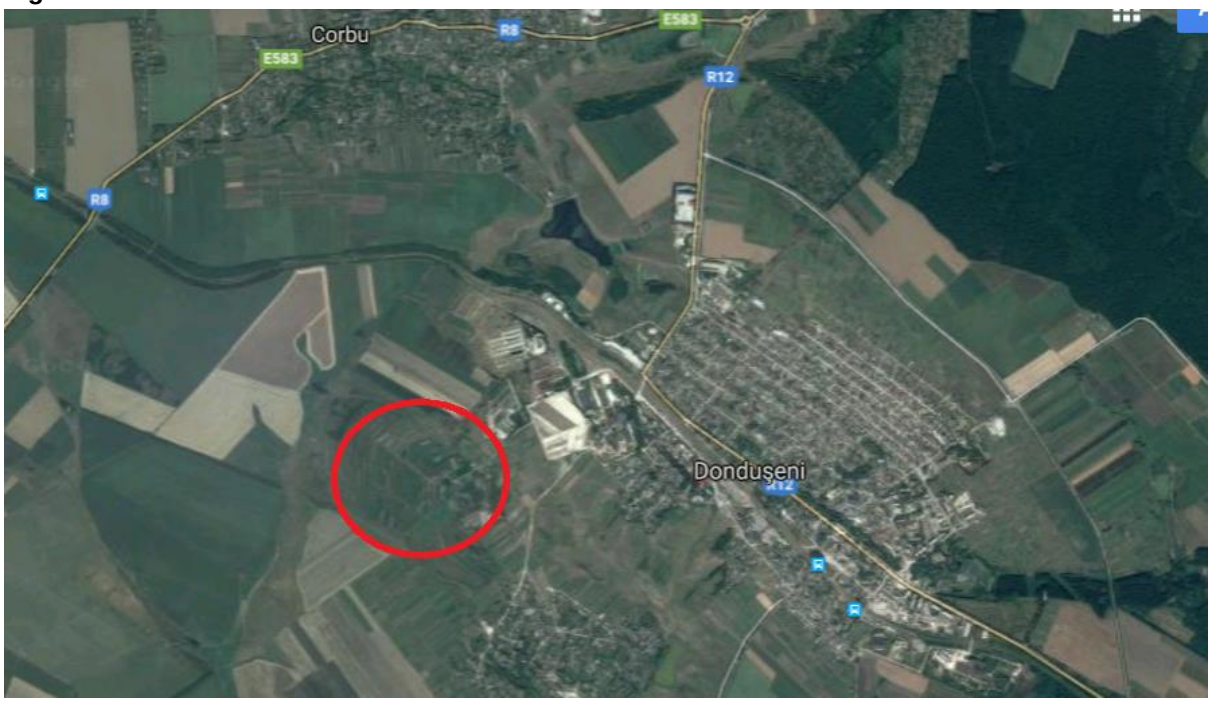
- Minimization of emissions from gas and leachate by appropriate treatment and protection systems;
- Provision of connected facilities according to the waste management plan (composting, transfer platform)
- Provision of designated areas for future extension (e.g. for hazardous waste disposal)

10.5.2 Site description

The selected site for the future landfill is located on the western border of Donduseni town at the premises of an abandoned sugar factory.

Figure 10-18 shows the location on the air view map, Figure 10-19 shows the plot on the cadastral air view map. The available plot for the landfill is located in an sector which hosted waste water sedimentation basins from the factory. The landscape is hilly with slopes from Northeast to Southwest The northern and eastern boundary has an altitude of up to 260 m NN, the lowest point in the South-West corner is situated on 232 m NN. The slope inclination varies around 3-5 % depending on the direction. The land appears abandoned for quite a while. The former sedimentation ponds are still visible (Figure 10-20).

Figure 10-18: Future landfill Donduseni - location



Source: GIZ/MSPL

Figure 10-19: Future landfill Donduseni - cadastre plot

Source: GIZ/MSPL

Figure 10-20: Future landfill location Donduseni - view to South-West

Source: GIZ/MSPL, Kölsch

The access to the area is good via the premises of the former sugar factory. The road is a concrete construction, which needs some rehabilitation.

Open water was found in the opposite of the western edge of the plot (small creek) and along the southern boundary (drainage ditch. The groundwater level is situated between 7.6-14 m below the surface.

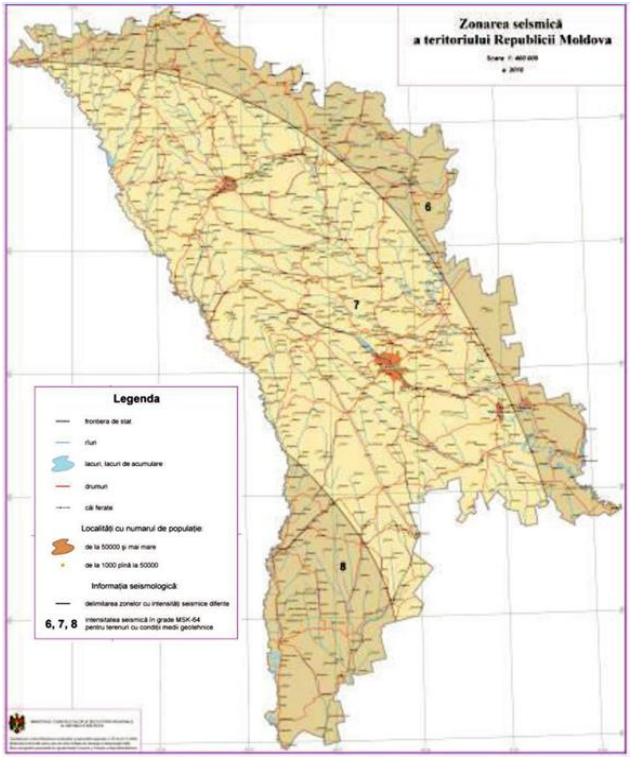
The soil conditions on site have been investigated by geotechnical company INGEOCAD. A separate report on the geotechnical testing is available. INGEOCAD stated generally "conventionally favourable conditions for construction". The boreholes 1, 3 and 4 represent

the subsoil conditions in the future tipping area of the landfill, while the landfill facilities will be established in the areas of borehole 2. The geotechnical investigation obtained in all boreholes almost identical subsoil conditions with clay as the only soil layer. Just in borehole 2 the clay is overlaid by a 2.5 m layer of loam. The major soil properties are:

- Shear strength: angle of internal friction φ = 21°, cohesion 18 kPa (loam)
  angle of internal friction φ = 22°, cohesion 63 kPa (clay)
- Density (natural) ρ = 1.76 t/m^3 (loam), 2.10 t/m^3 (clay)
- Compressibility E = 10 MPa (loam), 24 MPa (clay)
- Hydraulic conductivity k-value: 2 x 10^{-6} m/s (loam), 1-4.6 x 10^{-8} m/s (clay)

Those properties indicate favourable subsoil conditions for the construction of a landfill barrier, since the subsoil already acts as natural geological barrier. The hydraulic conductivity of the clay layers is low. It seems to be likely, that the subsoil can be used as mineral liner system for the landfill after additional processing. However, for final evaluation, more detailed hydro-geological laboratory testing is required. It should be noted, that the sediment in the former basins was not subject to the geological investigations. That material most likely needs to be excavated, but can be used as daily earth cover material during landfill operation.

Figure 10-21: Seismic map for Moldova



Source: GIZ/MSPL, GOPA

According to the seismic map of the Republic of Moldova from 2010 (

Figure 10-21) the proposed landfill location is located in an area of level 7 out of 9 levels (level 1 = low seismic activities, level 9 = high seismic activities). Furthermore the map shows that the whole project area belongs to level 7 zone. However better locations from the seismic point of view cannot be found in the Rayons in the North. Thus there is a risk of earthquakes in the area. International geotechnical regulations do not require particular improving measures for landfills in zones with an increased risk of earthquake. However, the seismic risk needs to be considered in the landfill design (stability analysis) and has consequences regarding the required quality of construction works, landfill operation and landfill monitoring (settlements).

Considering the good geological and hydro-geological condition at the site in Donduseni (low soil permeability and appropriate distance to groundwater of more than 7 m), the Consultant evaluates the local situation as suitable for landfill construction, if appropriate technical and operational measures are applied.

10.5.3 Layout

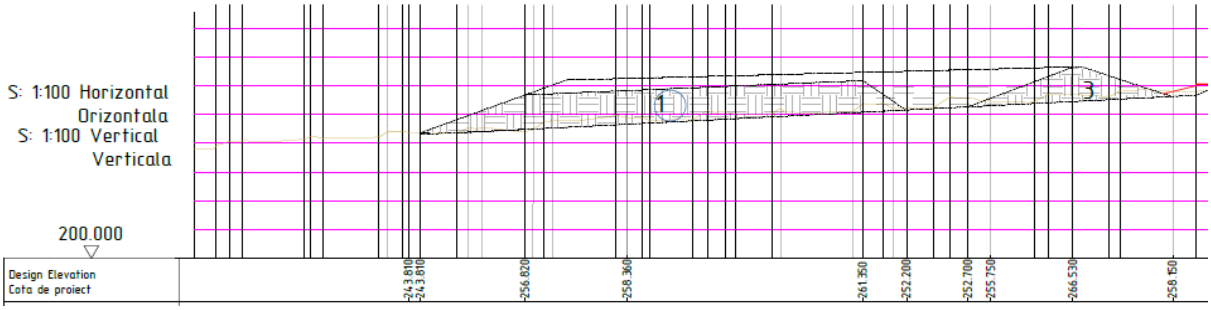
Figure 10-22 shows the site map of the future landfill in Donduseni. The tipping areas are divided into three zones. In terms of landfill airspace the first two cells provide 180,000 m^3 airspace each, while the third cell is larger (290,000 m^3) forming one single landfill body covering the first two cells. The cross section (

Figure 10-23) explains how the landfill body develops during the phased construction of liner systems.

Figure 10-22: Future landfill Donduseni - site map

Source: GIZ/MSPL

Figure 10-23: Future landfill Donduseni - cross section



Source: GIZ/MSPL

The new landfill will have a total lined landfill area of 9.15 ha. The construction will start with cell 1 in 2021. In 2026 the neighboring cell 2 will be added. In 2031, the cell 3 will be constructed. The waste disposed in cell 3 will also cover the grandfathered areas of cell 1 and 2, which explains the significantly larger capacity compared to the extension of lined area. Table 10-15 summarizes the lay out.

Figure 10-22 illustrates also the location of the landfill installations (administration building, workshop etc.), additional facilities (transfer point, composting pad), access road and traffic areas.

Table 10-15: Landfill zones

Cell	Capacity [m³]	Area [m²]	Lifetime [y/m]	Start
1	180,000	35,600	5 y, 4 m	2021
2	180,000	30,700	5 y, 7 m	2026
3	290,000	25,200	9 y, 1 m	2031
Total	650,000	91,500	20 y	

Source: GIZ/MSPL

10.5.4 Technical features of landfill base liner system

Landfill liner

The main objective of a sanitary landfill is to protect soil, groundwater and surface water from emissions from waste disposal, particularly from leachate an gas emissions. Protection will be achieved by means of landfill barrier systems. Annex I of the Council Directive 1999/31/EC provides the general requirements for municipal landfills (

Table 10-16). Beside an artificial landfill liner (sealing) system, the EU Directive requires a geological barrier, which can be either natural (1 m) or man made (0.5 m). The hydraulic permeability should be less than $k_f = 10^{-9}$ m/s.

The subsoil on site does not fully match this requirement ($k_f = 10^{-8}$ m/s). Thus, the upper clay layer should be treated by loosing, ploughing and subsequent compacting in order to accomplish the required hydraulic permeability.

Table 10-16: Requirements for Base sealing systems (EC Directive)

Item	Requirements for Non-hazardous Waste Landfills
Natural Geological barrier	Permeability: 1.0 x 10^{-9} m/s Thickness of layer: > 1.0 m
Alternative: Artificial geological barrier	 Thickness of layer: > 0.5 m
Sealing system	Artificial sealing system
Drainage layer	> 0.5 m

Source: GIZ/MSPL

The major component of the landfill base liner system is the artificial liner. A 2.0 mm thick HDPE geomembrane will be installed on site to provide a reliable state-of-the-art lining system. Individual panels of liner are thermally welded together to form a homogenous seam. The geomembrane has the following features:

- Highly impermeable (10^{-14} m/s) barrier to gases and liquids, which ensures protection of the groundwater;
- Resistant to corrosion and most chemicals;
- Resistant to biological degradation;
- Dimensional stability;
- UV stabilized;
- Flexibility allows the ground movement without cracking;
- Unaffected by wet/dry cycles;

- Able to be installed in vertical situations.

The design of the geomembrane has to meet the following criteria:

- HDPE geomembrane should be installed in direct and uniform contact with the underlying layer (geological barrier);
- The geomembrane has to be physically compatible with the proposed subgrade and backfill properties;
- The geo-membrane should be capable of withstanding the anticipated short-term and long-term stresses due to facility construction and operation;
- The number of pipe penetrations through the geo-membrane should be minimized to the extent possible;
- The geo-membrane friction properties have to be compatible with other components of the liner system to minimize mechanical stresses on any component and to achieve stability.

Protection layer

The geotextile layers provide a protection for the geomembrane against punctual penetrations by particles from the drainage layer placed above the geomembrane. Geotextiles are designed and adapted especially for landfill applications:

- High puncture resistance at minimum cost;
- Wide widths for minimum overlap.

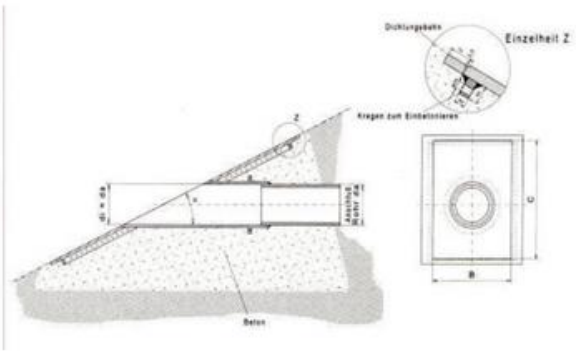
As protection layer a geotextile with a specific weight of 1,200 g/m^2 is proposed.

Drainage system

The drainage system consists of a filter layer made crushed stones or gravel with a corn size distribution 8/32 mm or 16/32 mm with a coefficient of permeability $k_f > 10^{-3}$ m/s and a thickness of layer of 50 cm. The lime content is limited to 10%. The leachate emerges from the disposed waste into the drainage layer and flows within this under gravity to the leachate collection pipe, which transports the leachate further to the shaft at the deepest point of the sealed landfill base. From the leachate collection shaft the leachate is flowing through a non-perforated pipe of HDPE to the leachate storage and treatment basin.

The leachate collection pipe will penetrate the base sealing system at the deepest point of the sealed area. As this is always a critical part of the landfill construction, a special construction as shown in the following figure, will be used.

Figure 10-24: Penetration of leachate collection pipe through sealing system.



Source: GIZ/MSPL, *GOPA*

More technical details on the conceptual design and the corresponding drawings are presented in the Annex.

10.5.5 Technical features of Leachate treatment

Leachate generation

Leachate at landfills is generated from precipitation (rainfall and snow) as well as from the excess humidity of the disposed waste due to compaction. Leachate contains various pollutants and has to be cleaned before discharging. Usually a “technical” treatment of the leachate is necessary to clean it, but under certain circumstances (low precipitation and high grade of evaporation) an alternative solution is feasible. Leachate is collected in a storage pond and will be evaporated during the summer time. The dimensions of the leachate collection, storage and treatment systems are mainly depending on:

- Precipitation and climate-hydrological condition;
- Size of landfill and division into sub-cells with rainwater separation;
- Retention capacity of the waste;
- Capacity of leachate treatment.

The leachate production should be minimized in order to reduce effort and costs for leachate treatment. A system of 3 cells with 35,600 m², 30,700 m² and 25,200 m² is proposed. Based on this assumption the quantity of leachate and evaporation was calculated. The calculation is based on long term meteorological data of the years 1959 - 2012, which indicate that the average precipitation is 595 mm/year but varying between 307 (year 2003) and 818 mm/year in 1966.

Table 10-17: Meteorological data

	unit	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Okt	Nov	Dec	Ave
Precipitation	mm	32	32	31	38	55	74	61	54	48	32	37	40	45
Ave Temp	°C	-2	-1	4	10	16	20	22	21	17	11	5	0	10
Max Temp	°C	9	11	19	23	28	31	33	33	29	24	17	11	23
Min Temp	°C	-14	-13	-7	0	5	10	12	11	6	-1	-6	-12	-1

Source: GIZ/MSPL

For the estimation of leachate the landfill operation scenario with the largest quantity of leachate (critical situation) was investigated: In a particular status of operation 2 cells (no. 2 and 3) are in operation and open to the sky without any effective soil cover, while cell 1 has been temporarily covered. According to the condition of the surface different quantities of leachate will be generated. The typical leachate generation is about 50 % of the precipitation (remaining is evaporation). In covered areas the leachate generation rate is smaller (30 %),

because the soil has a retention effect and prevents the water from infiltrating to the waste. Under these circumstances the leachate quantity produced at the landfill will range between 22,994 and 31,612 m³ as a maximum during the critical operation period, which is after the start of cell 3 (Table 10-18).

Table 10-18: Estimated leachate generation

Cell	Area [m²]	Leachate rate [%]	Leachate generation ave 595 mm [m³/year]	Leachate generation max 818 mm [m³/year]
1 (soil covered)	23,300	30 %	6,355	8,713
2 (operation)	25,600	50 %	9,133	12,556
3 (operation)	31,800	50 %	7,506	10,319
Total	80,700		22,994	31,612
1 (operation)	23,300	50 %	10,591	14,560

Source: GIZ/MSPL

From the landfill the leachate is flowing to the leachate basin which is located beneath the waste disposal area. It will be used as buffer for the leachate treatment plant and for evaporation also.

Leachate treatment

At Donduseni landfill the evaporation rate is relatively high. Hence the water surface in the leachate basin should be maximized in order to evaporate as much leachate as possible and to reduce the leachate quantity to be technically treated. The proposed surface of the basin is 1,100 m² and has a storage capacity of 2,800 m³. Water depth is 2.5 m.

It is assumed that the leachate treatment plant is working 300 days a year (65 days for repair and maintenance). During the critical phase of the landfill operation a maximum treatment capacity of around 4.0 m³ per hour is needed (31,612 m³/year / 300 days / 24 hours = 4.39 m³/hour). It is proposed to use a modular leachate treatment system which will be extended in parallel to the landfill extension. For the initial phase (cell 1) leachate treatment capacity will sum up to 2 m³ per hour (14,560 m³/year / 300 days / 24 hours = 2.02 m³ per hour). In case that the capacity of the leachate treatment plant is temporary not sufficient due to extraordinary strong rainfalls or longer operation breaks or other emergency cases, the landfill is constructed in a way that the leachate pipe can be closed by a valve and the leachate can be temporary stored in the landfill, which acts like an retention basin.

The process of anaerobic digestion of leachate goes through a series of steps, the most important being the acetogenic step followed by the methanogenic step.
Table 10-19 presents typical concentrations of major components in leachate from these two phases.

Table 10-19: Expected leachate concentrations

Parameter	unit	Acid phase	Methane phase	Discharge limits[1]
pH	-	6.0	7.5	6.5-8
COD	mg/L	24,000	2,200	125
BOD5	mg/L	14,000	400	25
Ammonia, NH_4-N	mg/L	900	1,000	2
Chloride	mg/L	1,900	2,000	300
Phosphate, PO_4-P	mg/L	30	8	
Suspended Solids, SS	mg/L	500	250	

Sulphate	mg/L	500	200	400
Iron	mg/L	400	10	5
Manganese	mg/L	20	1	
Zinc	mg/L	3	0.5	0.5
Copper	mg/L	1	0.2	0.1
Nickel	mg/L	1	0.2	0.5
Chromium	mg/L	1	0.1	0.9
Lead	µg/L	100	100	0.12
Cadmium	µg/L	10	5	0.1
Mercury	µg/L	10	10	0.05

[1] Extract from Annex N°2 of the regulation on requirements to collect, treat and discharge waste water to the water treatment system or to water bodies for rural and urban settlements

Source: GIZ/MSPL

The following design criteria are considered for the leachate treatment plant:

- The type of waste to be disposed has an impact on leachate quality. It is assumed that the new Donduseni landfill only receives municipal solid waste;
- The leachate treatment process is assumed to meet strict discharge requirements to receiving waters;
- The treatment plant will be designed in a modular form and will be constructed to serve the full capacity of the landfill (three cells). Consequently the treatment plant will be oversized at the beginning of its operation. However, a system will be selected which allows being operated on a lower capacity.
- Due to the fact that there is no realistic option to transport leachate from the landfill to a waste water treatment plant after a limited pretreatment a “full treatment“ of the leachate is necessary in order to match the requirements of direct discharge according to
- Table 10-19.

The main pollutants to be treated in municipal solid waste leachate are organic matters, ammonia and chlorides. Options for leachate treatment vary widely and depend on the discharge standards, climate conditions, quantity and quality of leachate generated. A combination of treatment methods may therefore be required. Table 10-20 summarizes the range of technical options to meet specific treatment objectives.

Table 10-20: Options for leachate treatment

Treatment Objectives	Range of Treatment Options
Removal of degradable organic substances BOD5	Aerobic processes: • Activated sludge; • Sequencing Batch Reactor (SBR) • Rotating Biological Contactor (RBC) • Aerated lagoon/Extended aeration Anaerobic processes: • Upflow anaerobic sludge blanket (UASB).
Removal of ammonia NH_4-N	Aerobic nitrification: • Activated sludge: • Sequencing Batch Reactor (SBR) • Rotating Biological Contactor (RBC) • Aerated lagoon/Extended aeration • Constructed wetlands Air stripping

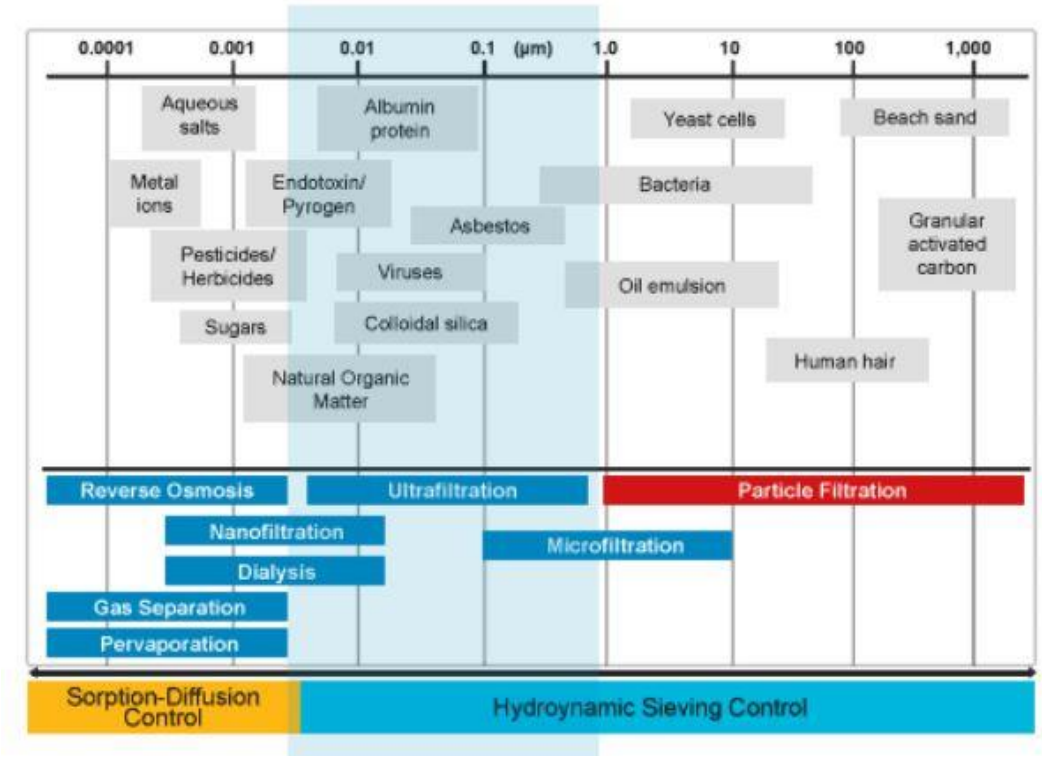
Treatment Objectives	Range of Treatment Options
Denitrification (Removal of nitrites and nitrates)	Anoxic Processes: • Sequencing Batch Reactor (SBR) • Constructed wetlands
Removal of non-degradable organics and toxics	• Lime/Coagulant addition; • Activated carbon; • Reverse osmosis; • chemical oxidation.
Removal of hazardous trace organics	• Activated carbon; • Reverse osmosis; • chemical oxidation.
Odour removal	Hydrogen peroxide
Removal of dissolved iron , heavy metals and suspended solids	Lime/Coagulant addition, aeration and sedimentation
Final polishing	• Constructed wetlands; • Sand filters.
Disinfection	Hypochlorite
Volume reduction/pre-concentration	• Reverse osmosis; • Evaporation.

Source: GIZ/MSPL

The Consultant proposes using the reverse osmosis process for cleaning the leachate. The reverse osmosis (RO) technique aims to extract clean water from the aqueous solution of organic and inorganic contaminants that constitute the landfill leachate. The process exploits the natural phenomenon of osmosis where by, if two aqueous solutions, with different degree of concentration, are separated by a semi-permeable membrane, water from the weakest solution will pass through the membrane to dilute the higher concentration solution on the other side. The process will continue till solutions on both side of the membrane display the same degree of concentration.

With reverse osmosis the process is reversed. Pressure is applied to a water solution, (leachate), against a semi permeable membrane forcing the water molecules to pass through the membrane, thus forming the clean “permeate”. The majority of the solutes or contaminants will be left behind forming the “concentrate”. Reverse osmosis is the finest physical separation method known. In contrast to normal filtration where solids are eliminated from a liquid, reverse osmosis succeeds in removing solutes from a solvent (Figure 10-25).

Figure 10-25: Filtration effects of different treatment options



Source: GIZ/MSPL

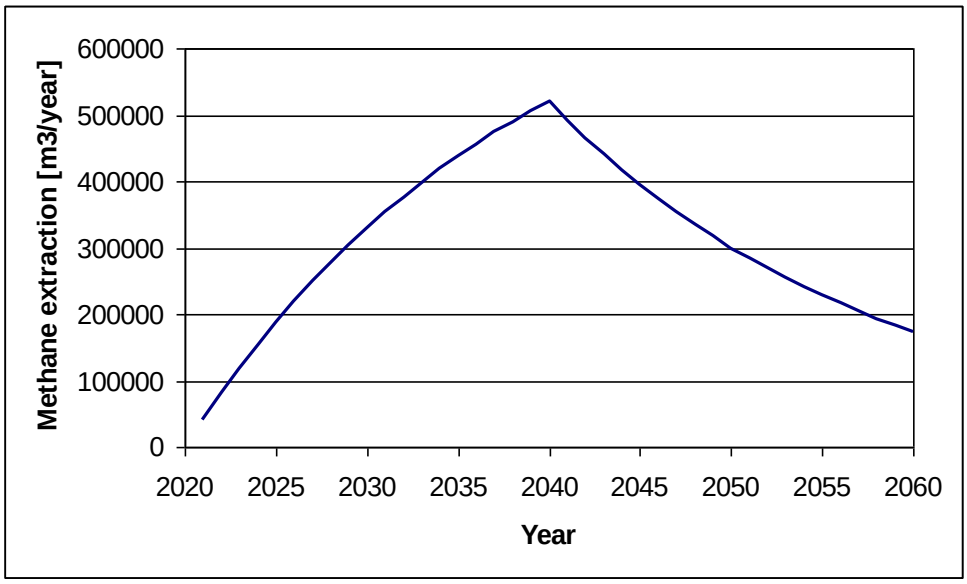
As a technology, RO is well established in wastewater treatment applications. Advances in membrane technology, in particular in the last 15 years, have allowed the development of RO systems designed specifically for the treatment of leachate. The retention efficiency is primarily depending upon the molecular weight and polarity of contaminants. Reverse osmosis membranes can result in the retention of more than 98% of large molecules dissolved in leachate. Ions of valance 1 such as Na^+, Cl^- can also be retained. Most commercially available plants are constructed as two stage plants with contaminant removal rates better than 99.6%. Where unusually high strength leachate is treated or very stringent discharge consents apply, three stage plants can be employed and achieve contaminant removal rates better than 99.98%. Reverse osmosis leachate treatment plants are widely used on landfill sites throughout Europe. More than 100 plants are currently operational, some of them for longer than ten years (status 2007).

10.5.6 Landfill gas system

Since only limited activities regarding the segregation and treatment of organic waste components are in place, the waste will still have a high bio-degradable content. The carbon content (TOC) is estimated to be 150 kg/m³ waste.

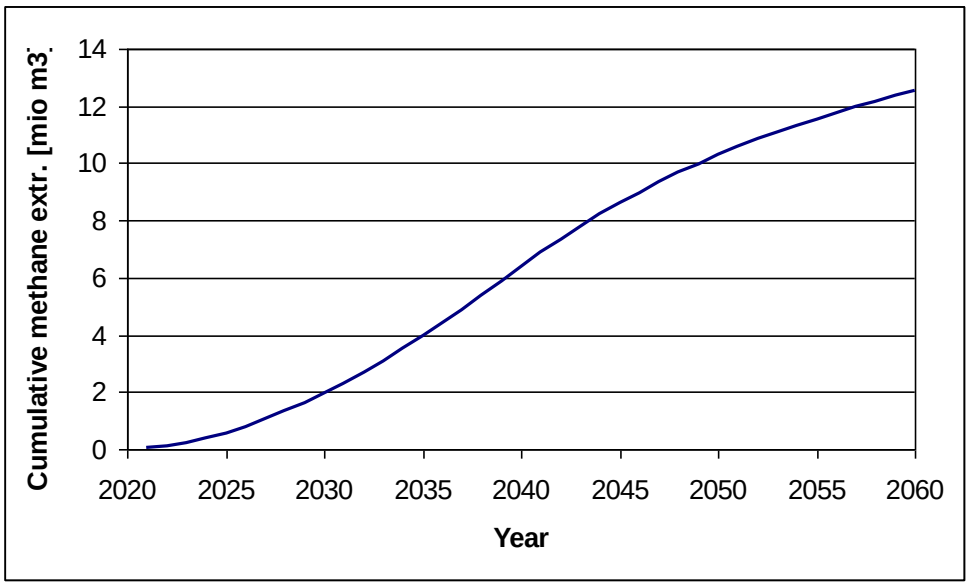
Gas quantities are estimated for a waste disposal period of 20 years. The calculation of landfill gas generation include a total period of 40 years (post closure period: 20 years). The calculation has been carried out using a the so called first order decay model, which is a popular gas generation model in CDM projects. The collection rate was assumed with 60 %, while 40 % of the gas is leaving the landfill in an uncontrolled way via the surface. During the 40 years calculation period a total amount of 12.5 Mio m³ methane will be extracted from the landfill.

Figure 10-26: Estimated annual methane gas generation



Source: GIZ/MSPL

Figure 10-27: Estimated cumulative methane gas generation (till 2060)



Source: GIZ/MSPL

The highest gas extraction happens in 2040 with 520,000 m^3 methane or 59 m^3/h. Assuming a methane concentration of 50 % in the landfill gas, the maximum landfill gas flow will be 118 m^3/h.

The landfill gas generation starts usually 6-12 months after waste placement has begun, depending on type and quantity of waste. To collect landfill gas, so called gas wells are needed, consisting of vertical gravel ducts (diameter 0.6-0.8 m), supported by PEHD drain pipes placed in the middle of the gravel. These wells are placed directly in the waste.

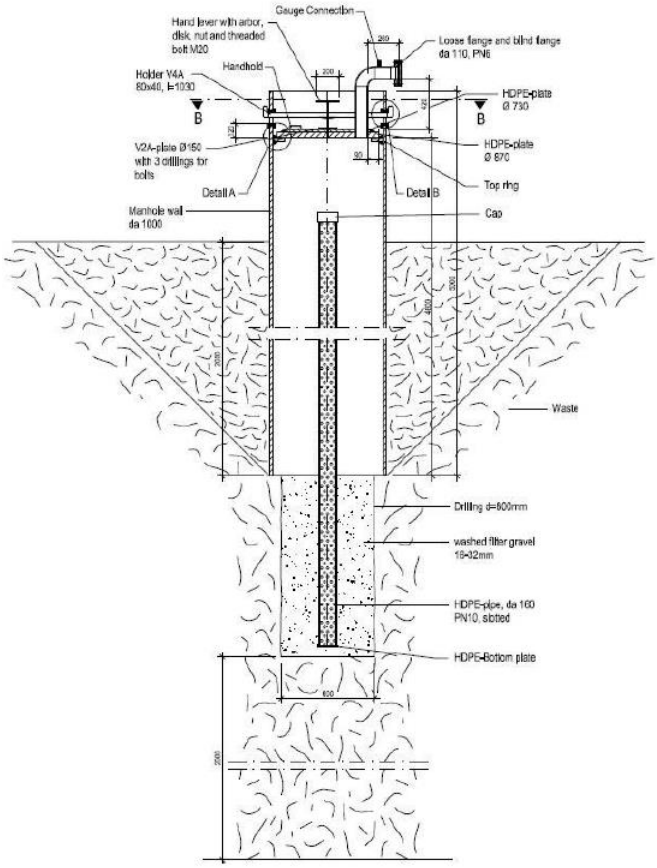
Two possibilities are generally available for the construction of the wells:

- Drilling of the wells after waste disposal is finished;
- Construction of gas wells in parallel to the waste disposal.

Considering the fact that special equipment is needed for drillings in waste with a diameter of 0.8 m, the construction of the gas wells in parallel to the waste disposal ac-cording to the following procedure is proposed: Steel pipes with a diameter of 0.8-1.0 m and a length of 4.0 m have to be placed on the first waste layer of waste (2.0 m thickness). They will be filled with gravel (16/32 mm). In the middle of the pipes a drain-pipe of PEHD (200 mm) shall be placed. The steel pipe can be closed with a removable lid. In parallel to the waste disposal, the area around the pipe will be filled and compacted up to the top of the pipe. Afterwards the pipe will be lifted up 4.0 m by a crane or excavator and the procedure starts again. Figure 10-28 illustrate the technical scheme of those vertical gas wells. The installation and construction works will be executed by the landfill operator. The supply of materials according to the following list will be part of the tender.

The blower station is placed in a steel container of 20 feet length with two separate rooms. One room is equipped with the blower technology (drive over belts, sealing gasket, pressure shock proof, installed on a base frame). The maximum gas flow of the ventilation system should be 120 m^3/h.

Figure 10-28: Gas well principle



Source: GIZ/MSPL

Other provisions for working safety and system control are as follows:

- Area air supervision;
- Gas analysis system for the permanent analysis of CH_4, CO_2 and O_2 in the landfill gas;
- Illumination facility inside the container;
- Ventilation inside the container;
- Electric steering control for the flare and blower technology and the security technology.

The extracted gas will be directed to a gas flare for combustion. The flare features the following specifications:

Table 10-21: Technical specifications of gas flare

Maximum gas flow	About 120 m^3/h
Gas input pressure	Min 20 mbar
Methane in landfill gas	max 60 Vol. %
Thermal power	about 700 kW
Temperature of combustion:	1,200 ˚C
Total height	about 10,000 mm
Furnace Height	about 7,000 mm
Furnace diameter	about 1,700 mm

Source: GIZ/MSPL

The entire process is controlled via a control panel, which will be installed in the control room. A schematic circuit diagram displays the main operation parameters of the degassing system:

- Negative pressure before the blower in mbar;
- Methane concentration in the gas collection beam (mixed gas and each single collection pipe in %;
- Quantity of landfill gas in m^3/h;
- Revolution indicator for the blower in %;
- Pressure behind the blower in mbar.

The degassing system will be constructed in a way that a gas engine for production of electricity can be included at a later stage, after having reliable information about gas quality and long term quantity.

Figure 10-29: Gas venting station and high temperature gas flare

Source: GIZ/MSPL, GOPA

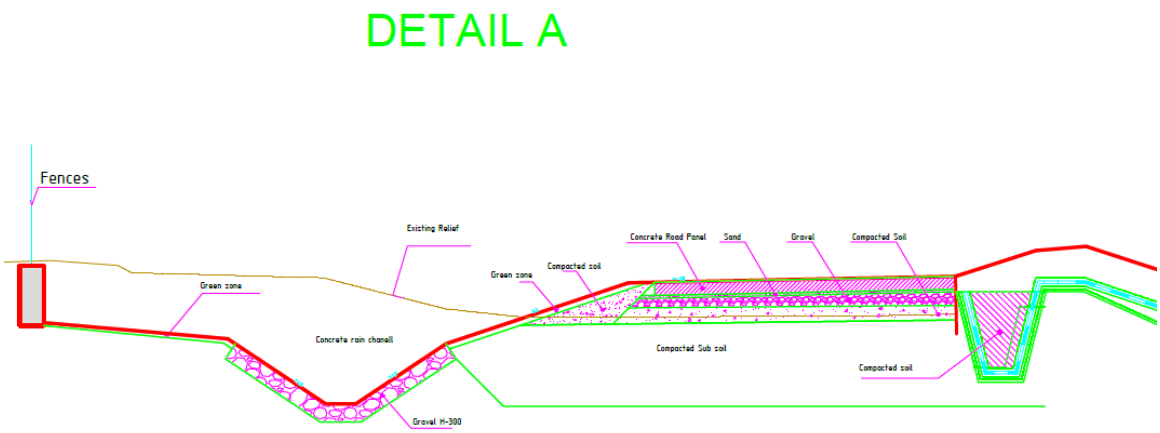
10.5.7 Landfill infrastructure

Storm water collection and discharge

It should be avoided that storm water is flowing from outside into the waste disposal area. For this reason the tipping area is surrounded with a ditch (

Figure 10-30). After landfill closure and capping the will also collect water from the covered landfill surface.

Figure 10-30: Storm water drainage



Source: GIZ/MSPL

The total length of ditches is 735 m. The storm water will directed through a surface water storage basin at the lowest point of the landfill. Capacity of the storage basin is 1,400 m³.

In the storage basin water from the following sources will be collected:

- Water from outside the landfill (see description above);
- Cleaned water from Leachate treatment plant;
- Water from waste disposal cell 2 and 3 as long as they are not in operation;
- Water from internal roads.

Rainwater from the asphalted areas and roofs of buildings in the reception area will be directly infiltrated in a ditch around the reception area. The base of the pond, up to the maximum water level will be sealed with clay from the landfill area excavation. The clay is protected upside by a geotextile of 500 g/m² weight. As final cover crushed stones will be used, the thickness of the stone layer will be 10 cm. The storage basin features an overflow and is connected to an ditch, which leads to the small creek in the valley.

Fire protection

Fire protection will be provided through several technical options on site.

- Water for fire fighting can be taken from the 1,400 m³ storm water basin (described above).

- A sufficient number of fire extinguishers will be placed in all buildings of the landfill, due to detail design and local standards.
- Experience shows that water has limited effect, only, when fighting landfill fires. Bigger fires within the landfill body can be avoided by proper compaction of waste by means of using a waste compactor. In case of smaller fires on the landfill surface during the dry season, the fire should be covered with soil, preferably cohesive soil. For this a soil storage at the waste disposal area with a minimum capacity of 500 m^3 will be placed during the landfill operation.

Public supplies (water, waste water, electricity)

The closest electricity line is at the former sugar factory. A maximum electricity consumption of 100 KW/hour is assumed as design criteria for the access. details concerning the public supply needs to be clarified with the service provider

Public water network is also available in reasonable distance. Some additional pipe construction may be needed to connect to the water supply at the factory premises. A maximum water consumption of 150 liter per minute, respectively a daily consumption of 15 m^3 is calculated. To assure a stabile water pressure during the operation of the facilities a high level water tank with a capacity of 50m^3 will be placed next to the reception area, if necessary. In practice the water for technological consumption (compost moistening, spraying asphalt for dust reduction and watering of green areas) will be taken from the surface water storage basin respectively from the leachate storage of the compost plant (compost irrigation).

Waste water is generated in the social rooms, only. It will be cleaned in a small 3-chamber waste water treatment plant with biological cleaning by aeration. Purified waste water will be discharged to the storm water ditches for infiltration or further transportation to the storm water basin. The pre-fabricated system should have sufficient capacity for 30 persons and includes decantation and anaerobic treatment, biological treatment and disinfection.

Waste water from the cleaning of equipment and wheel washing is estimated to 100 vehicles per week as a maximum with a water consumption of 100 l per washing process as a maximum. This water will be directed to the waste water treatment plant after passing an oil separator.

Access road and traffic concept

The traffic system to and inside the landfill area comprises:

- Access road to the landfill;
- Reception area asphalted;
- Ring road around the landfill;
- Ramp for entering the waste disposal area by waste collection trucks;
- Unpaved roads (temporary) at the disposal area.

The existing access dirt road to the landfill will be improved in a way that it matches the vehicle requirements (design criteria gross vehicle weight: 60 t). The road shall be 5 m wide and paved.

The reception are will be completely asphalted and should have the following structure:

- Concrete-asphalt – wearing course (6 cm);
- Bituminous conglomerate – road base asphalt (5 cm);
- Crushed stones – sub base layer (compaction rate of Trγ >90%) – (20 cm);
- Cobbling stone layer – road foundation (compaction rate of Trγ > 90 %) – (30cm);
- Base (compacted original soil).

The same rigid base will be in front of all major landfill facilities and all the way down to the access to the tipping area (see

Figure 10-9).
On the western and southern boundary the landfill is surrounded by a ring road in order to access every part of the landfill for maintenance. The road will have a width of 3.0 m and is unpaved.

In order to assure that the waste disposal trucks can enter the waste disposal area all over the year temporary internal roads have to be constructed. The internal roads will be constructed from demolition waste if available. Hence a management of collection and intermediate storage of those waste at the landfill area is needed. The construction of those internal roads has to be done by the landfill operator and should follow the requirements of the landfill operation plans.

Waste delivery is done during the early evening hours as well. Hence lighting of the reception area must be ensured. It is recommended to install 150 W reflectors, provided with IP 54 protection, installed on the external wall of the building or on lampposts be-side the roads and the platform. The value of the overall lighting should be 80 lux.

Administration and social building

Table 10-22: Specification administration and social building

1.	Meeting room	49 m^2
2.	Landfill manager	16 m^2
3.	Secretary office	12 m^2
4.	laboratory archive for waste samples included	16 m^2
5.	Social room with tea/coffee kitchen	15 m^2

6.	Locker room, including showers (men)	16 m^2
7.	Locker room , including showers (women)	16 m^2
8.	Central control station	15 m^2
9.	2 rooms for reserve (2 x 10 m^2)	20 m^2
10.	services / storage (2 x 8 m^2)	16 m^2
11.	Toilets for men for women (2x 7 m^2)	14 m^2
12.	Corridors	37 m^2
Total		242 m^2

Source: GIZ/MSPL

For landfill administration as well as to provide social and sanitary facilities to the staff, a site operating and office building is needed. The following rooms will be provided in the site operating building on one floor: The required gross plot area of the site operating and staff facilities building is thus approximately 242 m². Next to this building around 10 parking spaces shall be provided for the staff and visitors.

Workshop / garage

For vehicles belonging to the landfill and the connected facilities, a garage constructed as a closed building with dimensions of 12 x 30 m will be provided for the wheel loader, tipper truck, pick up and tractor. For the compactor a separate parking garage will be established next to the tipping area at the East side of the tipping area.

A workshop for servicing and maintaining the vehicles as well as a storage for spare parts and operating supplies will be integrated in the garage. For fuelling the vehicles a stationary diesel filling station with one filling pump will be erected on the site operating yard. The diesel tank should be calculated for approx. 2 weeks of landfill operation. Depending on the machines working hours between 150–250 l diesel per day are needed for landfill, composting and sorting facility. Hence the capacity of the fuel tank should not be less than 3,000 l.

Fence and gate

The landfill area is surrounded by a fence of minimum 2.50 m height. The gate at the access is opened only during the opening times of landfill. The fence is necessary to avoid unauthorized access of people, illegal waste dumping and to hinder bigger animals from entering the landfill.

Wheel washing and cleaning

The trucks coming from the landfill, having unloaded their waste, will return to the reception area. If necessary, they have to be cleaned in the truck cleaning station. The truck cleaning station of approx. 4 x 18 = 72 m² is placed between reception area and the internal access road and is asphalted. It consists of a flat basin of approx. 10 cm depth to collect the waste water.

After the trucks have stopped in the basin they can be cleaned by a high pressure water washer. The waste water will be collected in a shaft with oil separator and with the possibility for sedimentation of fine waste particles. The tank will be emptied by a tank truck.

It is assumed that 10 trucks a day will be cleaned on 150 days per year. Water consumption per cleaning procedure is calculated with 100 liter. Hence waste water storage for 150 m³ per year is required. Intervals of emptying shall be once per months. A storage tank of 150 m³ / 12 = 15 m³ including 20% safety capacity should be constructed.

Within the reception area a separate area for storing containers will be constructed. Roll on-roll off containers for transport of cover soil, demolition waste (for internal road construction purposes) and temporary storing of unidentified waste can be placed there. In addition a small washing place for cleaning waste bins and collection containers will be installed there.

Weighbridge

All incoming waste deliveries will be weighed and registered. For this reason a weigh-bridge for trucks of 18 x 3 m will be installed. The weighbridge is located in the entrance area. Directly beside the weighbridge, a weighing office will be constructed. The weighing operator has visual contact to the truck driver and the possibility of a visual inspection of the truck load by using a mirror, outside installed at a mast. In addition, a movable and freestanding ladder is placed in front of the weighing office.

The weighing office is equipped with a computer and special weighing software to collect all data such as the type, characteristics, weight, the origin of the waste, name and address of supplier and the precise location where the waste is deposited at the landfill.

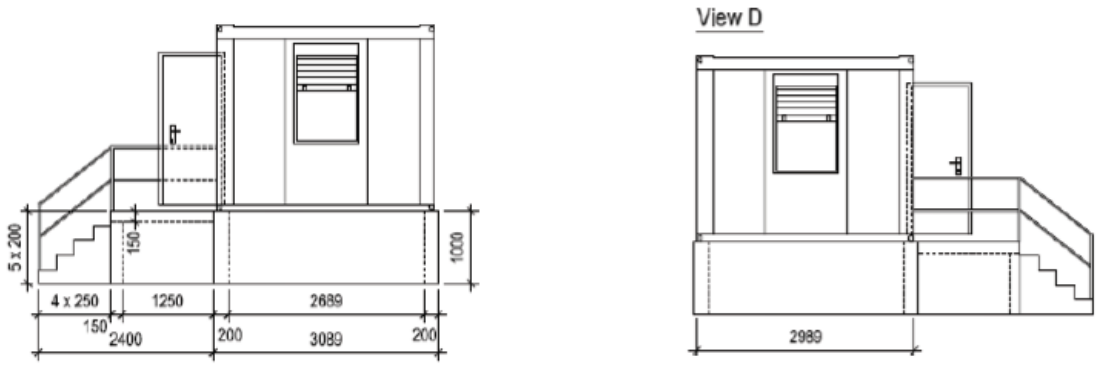
Features of the Weighbridge:

- Measuring capacity: 40 t;
- Load capacity: 50 t;
- Size of the weighbridge: 3.00 m x 18.00 m;
- Scale: 20 kg.

The secondary equipment such as microprocessor controlled weighing terminal, computer, software, printer and all connections between the weighbridge and the weighbridge office for weighing operation has to be delivered and installed.

The weighing procedure consist of two steps (in and out weighing). Initial weighing takes place after having entered a function number with intermediate storage of the date, numeric or alphanumeric identification of the initial weight. A second weighing of the unloaded truck takes place after having entered a function number with calling the data stored under the above mentioned identifier or by manually entering the initial weight by means of the keyboard with automatic calculation of the net weight value. In addition, a weighing ticket printing facility with connection to the weighing terminal for individual sets of tickets DIN A5 broadsheet print, self-duplicating paper by means of single page take-up or for usual listing prints on endless paper. Tickets contain the following data: date, time, incremental number of the weighing tick-et and initial weight value.

Figure 10-31: Weighbridge office container



Source: GIZ/MSPL

Figure 10-32: Example for landfill entrance area (Güngor landfill/ North Cyprus)

Source: GIZ/MSPL, GOPA

10.5.8 Closure of the landfill

The Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste requires a surface sealing system for landfills for municipal waste according to Table 10-23:

Table 10-23: Requirements for landfill top liner systems

Top sealing	Requirements for non-hazardous waste landfill
gas drainage layer	Required
artificial sealing system	Not required

Impermeable mineral layer	Required
drainage layer	> 0.5 m
top soil cover	> 1.0 m

Source: GIZ/MSPL

The drainage layer of 0.5 m thickness required in the landfill directive could be sub-stituted by a drain mat in order to save landfill capacity. As both solutions can be evaluated as equivalent the drain mat should be tendered as alternative item and finally decided by the price offered.

Considering the facts that the final surface sealing for the new landfill will be constructed after landfill closure following year 2040 and the discussion about cheaper and simplier technically equivalent surface sealing systems is still running, alternative sealing systems should not be excluded at this stage of the Project.

10.5.9 Landfill equipment

Figure 10-33: Major landfill equipment (left above: compactor, right above: wheel loader)

Source: GIZ/MSPL, Kölsch

For the operation of the landfill the following main vehicles and mechanical equipment are needed (Figure 10-33):

- Landfill compactor: A large landfill compactor (approximately 30 tonnes) would be preferred for crushing of large waste items and for appropriate compaction of the waste layers;
- Wheel loader: A wheel loader is needed for loading of soil and gravel materials.
- Tipper truck: A tipper truck is needed for internal transportation of soil and gravel materials;
- Water tanker: A water tanker trailer is needed for watering of internal roads and squares in order to prevent dust problems.
- Tractor: the tractor is needed for street cleaning (with assembled brush), pulling the tank truck and driving the windrow turner at the composting facility.

Besides that various small equipment and tools such as movable traffic signs; emergency power generator, remote radio, a set of tools for machine repair and a high pressure cleaner should be available for starting the landfill operation.

10.5.10 Landfill operation

Site regulations for waste deliverers

Prior to the start of landfill operations, site regulations will be drawn up containing the essential instructions for operational safety and orderly operation and in particular rulings to affect that:

- Only designated tracks may be used;
- The waste may only be disposed at the prescribed locations;
- The instructions of the landfill staff must be followed.

Operating manual for the landfill staff

Before commencing landfill operations, an operating manual should be prepared. In this manual, working practices will be laid down for normal operation, maintenance and servicing as well as during operational upsets, as necessary for maintaining proper disposal of the wastes and ensuring plant and equipment safety. These measures shall be harmonized with emergency plans and plans of action. The operating manual will define the tasks and responsibilities of each staff, the working practices, monitoring and maintenance measures, as well as obligations regarding information, documentary records and safe keeping of these.

An operation plan will be a part of the operating manual. The plan will contain all key regulations for landfill operation, in particular concerning the structure of the disposed wastes, the collection and treatment of leachate and other wastewater, as well as the nature and extend of internal inspection and monitoring.

Daily log

In order to record that the landfill is being properly operated, a daily log should be kept. This log will contain all data and information essential for landfill operation, these are particularly:

- Disposal records for the waste to be treated and disposed of in the facility;
- Records book for accepted waste;
- Documentation of discrepancies between the waste as supplied and the declaration of those responsible for the wastes, with the measures subsequently taken;

- Any special occurrences, particularly operational upsets, stating possible causes and remedial measures taken;
- Operating times and outage times of the plant and plant components;
- Results of investigations and measurements for on-site monitoring;
- Nature and extent of maintenance measures;
- Results of functional inspections.

The daily log must be checked by the landfill supervisor and signed off at least once per week. It shall be kept in a safe place, and protected from unauthorized access. The daily log shall be stored safely for at least five years following the start of landfill operation.

Inspection of wastes at reception

The acceptance of the incoming waste should be checked before is will be discharged to the tipping field. Direct inspections of delivered wastes at the landfill site shall concern essentially:

- Suppliers consignment papers, stating type of waste;
- Weight of the waste;
- Stating of disposal sector;
- Visual inspection of the waste (check of its appearance, colour, consistency, odour, degree of mixing and packaging);
- Section of disposal or intermediate storage;

The inspection measures shall be undertaken by the staff at the weighing scale and during unloading of the delivering vehicles. If doubts arise concerning the identity of the waste at the reception inspection, acceptance will be refused and this refusal will be recorded in the day log. In case that doubts arise during waste drop of, unloading or emplacement will be stopped, the waste already unloaded or emplaced will be secured (to protect, for example, against rainfall and access by unauthorized persons) and samples shall be taken. All involved parties (waste generator, landfill operator, regulatory authorities) shall be informed.

Tipping procedure

The landfill shall be operated in a way that persons will not be endangered. For this purpose the following will be designated:

- Incoming and outgoing access routes;
- Vehicle maneuvering areas;
- Unloading areas;
- Waste tipping areas.

The incoming and outgoing routes will be signposted. The traffic routes shall be maintained that they will be safe, for delivery trucks especially, even during bad and wintry weather.

Walking at the landfill tipping area must be reduced to a minimum to avoid unnecessary contaminations and health risks. The landfill disposal area will be divided into different sectors, marked by coordinates of length (A-Z), height (0-25) and width (a-z), so that the place of disposal can be specified, waste of similar nature can be disposed in the same sector and waste, which does not harmonize (sludge etc.) can be disposed in specific

sectors. The sector of disposal for each waste delivery will be stated during reception of waste. The sectors will be clearly signposted.

For the structure of each landfill section, an emplacement plan shall be prepared, and this section split up into a grid not exceeding 2,500 m² in plot area and 2 m in height. The following details shall be documented in the emplacement plan for the waste disposed in each sector:

- Nature of waste / waste code(s) / amount of waste;
- Location of emplacement (stating sector coordinates);
- Time of emplacement;
- Deviations from landfill operation plan.

After unloading at the instructed sector, the emplacement of waste is done by the compactor or the wheel loader. In order to minimize leachate production, reduce settlements, increase landfill capacity and reduce bad smells, birds and vermin, it is recommended to organize landfill operation according to the following principles:

- Waste disposal should concentrate on one area only;
- Separate disposal areas for waste collection trucks and bigger trucks and smaller cars (without hydraulic unloading system) should be prepared, to increase safety at the landfill;
- Clear definition of the disposal area by movable signs and barricades;
- Waste compaction has to be done by the compactor in thin layers of 20-30 cm and 4-5 overrides, as it shows the best result concerning waste compaction. The layers should have a weak descent to the middle of the landfill, to increase the stability of the landfill and to avoid leachate outflows at the landfill slopes (
-
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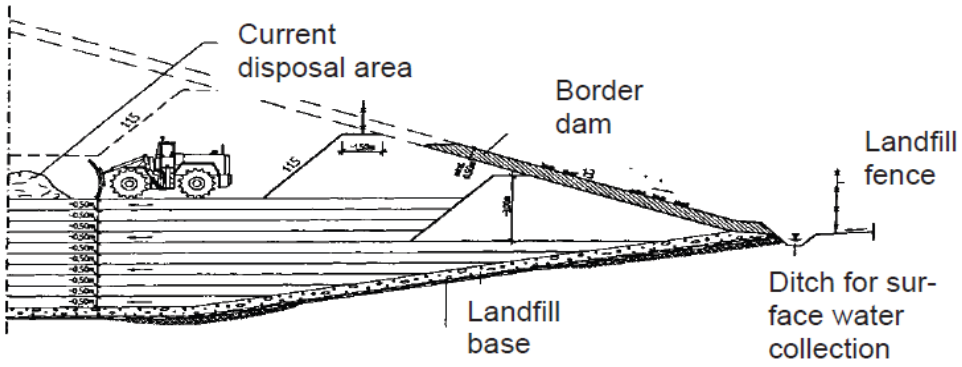
- Figure 10-34)
- The waste surface has to be covered at the end of each working day by a thin layer (ca. 10 cm) of inert waste (demolition waste, excavated soil). For these cover materials a temporary storage has to be established close to the waste disposal area;
- Landfill operation should be executed within border dams according to the scheme below in order to reduce dust and the flow of paper and plastic. For this excavation material and demolition waste should be used;
- All waste truck drivers should be directed by landfill operation staff, where to unload the waste;
- The landfill and the collected waste data should be checked by the person in charge, minimum once per week.

Figure 10-34: Waste tipping and compaction procedure



Source: GIZ/MSPL, GOPA

Landfill monitoring

Annex III of the Directive 1999/31/EC gives detailed instructions about control and monitoring procedures in operation and aftercare phases of landfills:

- Meteorological data
  Precipitation, temperature, wind, evaporation
- Emission data: water, leachate and gas control
  Leachate volume, leachate composition, composition of surface water, gas emissions
- Protection of groundwater
  Water table, ground water quality in monitoring wells
- Topography of the landfill, i.e. data on the landfill body
  Settlements

All analyses must be carried out by competent laboratories in compliance to legal requirements. All data and results of monitoring will be summarized and in yearly reports.

10.5.11 Staff

All staff of the landfill must be reliable and have available relevant expertise and practical experience. Education and further training of the staff for their specific tasks is essential. Landfill operation is calculated for an extended single shift operation. Minimum number of staff for the operation is 7 persons. As Donduseni is a joint facility, total number of staff on site is larger. Table 10-24 shows the staffing list. In total 23 staff are working on site.

Table 10-24: Staff list Donduseni

Position	landfill	composting	total
Facility Manager	1	0	1
Deputy Facility Manager	1	0	1
Foreman	1	0	1
Skilled worker	0	0	0
Administration clerk	0	0	0
Trained worker	1	1	2
Driver	2	0	2
Secretary/Porter	0	0	0
Unskilled staff	2	1	3
Unskilled sorters	0	0	0
Total	**8**	**2**	**10**

Source: GIZ/MSPL

11 Project description

11.1 Overall project description and investment measures

11.1.1 Collection and transport of municipal waste

Collection and transport of residual waste

Collection of residual waste will be organised for the entire population of WMZ 8. Individual houses in the towns of , Briceni, Edinet and Ocnita will be served by “door-to-door” collection; while the blocks of flats and the rural settlements will be served by “bring system”. The waste will be collected in containers as presented in the figure below.

Figure 11-1: Containers for collection of residual waste

1.1 m³ metal container (bring system)

120 l bin for individual houses (door-to-door)

Source: GIZ/MSPL, GIZ expert team

The waste collected in the 1.1 m³ metal containers in urban areas will be transported with 16 m³ trucks while the waste collected from houses will be transported by 10 m³ trucks. Both are envisaged as rear-loading compaction trucks. In rural areas approximately 50% of waste will be collected with 16 m³ trucks and the rest of the settlement will be served with 10 m³ vehicles.

The waste from Donduseni and Ocnita rayons will be collected and transported directly to the regional landfill in Donduseni.

The waste from Briceni Rayon will be collected and delivered to the transfer station near the city and then transported to the regional landfill. Im similar way the waste from Edinet Rayon will be delivered to a transfer station and then transported to the regional landfill.

Collection and transport of separately collected recyclables

In order to increase the resource recovery and to decrease the amount of waste designated for landfilling, the separate collection of recyclables will be introduced for all residents living in WMZ 8.

The separate collection will be implemented in 3 coloured plastic 1,1 m^3 euro containers – one for paper and cardboard, one for plastics and metals and one for glass.
The service of the containers will be provided with the same 16 m^3 rear-end loading collection vehicles used for collection of residual waste. The envisaged containers are presented in the figure below.

Figure 11-2: Containers for separate collection of recyclable materials

Source: GIZ/MSPL, GIZ expert team. Separate collection on Leiptzig

The separately collected waste from all rayons will be sorted in facility situated at the Edinet transfer station.
Besides the envisaged dry recyclables to be collected, the integrated system for waste management in the WMZ-8 will include separate collection of green waste from public areas. The collected green waste will be designated to a centralized composting facility situated at the regional landfill site.

11.1.2 Waste transfer and transportation

Due to the long distances between the waste collection areas and the landfill in Donduseni two waste transfer stations will be established in Briceni and Edinet. At the transfer station the waste will be reloaded from the collection trucks to bigger long distance trucks with a container capacity of 40 m^3. Separately collected recyclables are transferred here as well and transported to the sorting plant at Edinet transfer station in separate containers. The transfer station in Briceni is equipped with weighbridge office and social container to assure registration of type and quantity of delivered waste and to supervise all in- and outgoing vehicles permanently. The area of the transfer station is fenced. The site will be operated by 5 persons including two drivers for the waste transport to the landfill.

11.1.3 Sorting of waste

A sorting plants will be established in Edinet (capacity 4,000 t/year). The sorting plants is located at the premises of the transfer station with shared infrastructure (weighbridge, public supplies). The sorting plant consists of storage area, the sorting belts for manual sorting,

bunkers for the separated materials and baler, where the recyclables will be compacted for better transport. Waste sorting will be carried out by 17 workers.

11.1.4 Composting

One composting plant with a capacity of 1,000 t/year will be established at the new landfill in Donduseni. The green waste will be composted in open windrow composting. The composting will be operated by 2 staff supported by regular landfill personnel (driver, maintenance). For shredding and sieving the raw materials and later on the compost, a mobile sieving drum and a shredder is available.

11.1.5 Landfill

The new sanitary landfill for WMZ 8 with the four rayons Ocnita, Edinet, Donduseni and Briceni will be located at Donduseni. The total landfill volume will be 650,000 m^3 providing disposal capacity for 20 years. Technically, the landfill matches the requirements of the Landfill Directive of the European Commission for non-hazardous waste. At the site a composting will be placed also.

The landfill will be equipped with landfill liner systems at the base and after closure on the top, leachate collection and treatment systems as well as landfill gas extraction and treatment systems. In order to guarantee an all around the year operation of the landfill it will feature asphalt roads, street lighting and wheel washing. In- and outgoing vehicles will be weighed, registered and controlled in order to have a basis for correct billing and to avoid disposal of not acceptable waste. Mobile equipment on site include a waste compactor, wheel loader, tipper truck and tractor with trailers. This will assure that the landfill is operated in a way that emission can be reduced to a minimum. Landfill monitoring considering leachate, landfill gas, surface and groundwater as well as settlements of the waste body are mandatory during the landfill operation phase as well as during the aftercare phase when the landfill is closed and recultivated. The landfill will be constructed in three 3 phase with scheduled constructions in 2019/20, 2024/25 and 2029/30. The initial phase with landfill cell 1 (35,600 m^2) will be part of the investment project. Proposed investments include the infrastructure needed to operate the landfill as well as the connected facilities (composting).

11.2 Investment costs

Table 11-1 displays the investment costs related to collection and transport of residual waste in WMZ 8. The figures are presented for year 2021, when the supply of the collection and transport equipment will take place.

Table 11-1: Investment costs for collection and transport equipment WMZ 8

Cost item	Type	Cost in EUR
Containers	1.1 m^3	1,054,000
Containers CDW	Roll-on	54,000
Bins	120 l	216,000
Truck	16 m^3	1,040,000
Trucks	10 m^3	736,000
Vehicles for supervisors	car	60,000
Total		**3,160,000**

Source: GIZ/MSPL

Table 11-2: Investment costs for separate waste collection and transport equipment WMZ 8

Cost item	Type	Cost in EUR
Containers for paper & cardboard	1.1 m^3	78,800
Containers for plastic and metal	1.1 m^3	78,900
Containers for glass	1.1 m^3	75,600
Trucks	16 m^3	130,000
Total		**363,300**

Source: GIZ/MSPL

Table 11-3: Investment costs Donduseni

Item	Costs in EUR
Construction of the new landfill (initial phase)	3,777,800
Construction of composting facility	65,100
Landfill equipment	488,700
Composting facility equipment	290,000
Construction of the new landfill (cell 2)	2,273,833
Construction of the new landfill (cell 3)	1,768,865
Total invest at Donduseni	**8,664,298**

Source: GIZ/MSPL

Table 11-4: Investment costs Briceni

Item	Costs in EUR
Construction of transfer station	391,700
Transfer station operation equipment	230,200
Total invest at Briceni	**621,900**

Source: GIZ/MSPL

Table 11-5: Investment costs Edinet

Item	Costs in EUR
Construction of transfer station	444,600
Transfer station operation equipment	248,200
Construction of sorting facility	523,500
Sorting facility equipment	392,900
Total invest at Edinet	**1,609,200**

Source: GIZ/MSPL

Table 11-6: Investment costs per investment component (Investment phase 1)

	Investment cost item	Cost in Euro
1	Landfill construction	3,777,800
2	Landfill equipment	488,700
3	Transfer stations construction	836,400
4	Transfer stations equipment	478,400
5	Sorting stations construction	523,500
6	Sorting stations equipment	392,900
7	Composting facilities construction	65,100
8	Composting facilities equipment	290,000
9	Residual waste collection equipment	2,437,200
10	Separate waste collection equipment	312,700
Total		**9,602,700**

Source: GIZ/MSPL

Table 11-7 presents the total costs for the first phase of the project including costs for construction supervision, technical assistance, public awareness and contingency.

Table 11-7: Project costs (Investment phase 1)

	Cost Item	Cost in Euro
1	Construction Works and Buildings	5,202,800
2	Plants Equipment	1,650,000
3	Waste Collection Equipment	3,523,200
4	Design (5 % of item 1-3)	400,000
5	Technical Assistance (2 % of items 1-3)	300,000
6	Construction Supervision	690,000
7	Public Awareness (1 euro per person - residents in 2021)	200,000
8	Contingency (10% of items 1-3)	685,300
Total		**12,651,300**

Source: GIZ/MSPL

11.3 Operation and maintenance costs

The tables below present the operational and maintenance costs related to collection and transport of waste in WMZ 8. The tables are presented for the first year of operation (2021).

Table 11-8: Operation and maintenance cost for collection and transport of residual waste

Cost item	Cost in EUR	Remarks
Personnel costs	189,000	
Fuel costs	158,000	
Other consumables	16,000	
Maintenance	159,000	
Other costs	99,000	administration 10%, unscheduled services 5%
Insurance	27,000	
Total O&M costs	**649,000**	

Source: GIZ/MSPL

Table 11-9: Operation and maintenance cost for separate collection and transport of recyclables

Cost item	Cost in EUR	
Personnel costs	24,000	
Fuel costs	20,000	
Other consumables	0.500	
Maintenance containers	13,000	
Other costs	17,000	Administration and public awareness
Total O&M costs	**78,000**	

Source: GIZ/MSPL

The following costs cover the operation and maintenance of the transfer station in Briceni excluding the cost for transportation from Briceni to Donduseni landfill for the year 2021.

Table 11-10: Operation and maintenance costs for Briceni

Item	Costs in EUR / year
Maintenance	26,100
Personnel	15,200
Consumables	37,600
Admin	7,900
Taxes	3,500
Total costs per year	**90,200**

Source: GIZ/MSPL

The following costs cover the operation and maintenance of landfill Donduseni including the connected facility for composting for year 2021.

Table 11-11: Operation and maintenance costs for Donduseni

Item	Costs in EUR / year
Landfill	
Maintenance	98,000
Personnel	30,600
Consumables	346,700
Composting	
Maintenance	31,400
Personnel	5,000
Consumables	3,200
Admin	51,500
Taxes	22,700
Total costs per year	**589,100**

Source: GIZ/MSPL

The following costs cover the operation and maintenance of the sorting plant and transfer station in Edinet for the year 2021.

Table 11-12: Operation and maintenance costs for Edinet

Item	Costs in EUR / year
Transfer station	
Maintenance	28,200
Personnel	15,200
Consumables	24,600
Sorting plant	
Maintenance	36,300
Personnel	46,400
Consumables	24,300
Admin	17,500
Taxes	7,700
Total costs per year	**200,200**

Source: GIZ/MSPL

The operation and maintenance costs for all facilities in WMZ 8 (in year 2021) are summarized in Table 11-13

Table 11-13: Total operation and maintenance costs in WMZ 8, 2021

Item	Costs in EUR / year
Transfer station Briceni	90,200
Landfill and facilities Donduseni	589,100
Transfer/SS Edinet	200,2
Total costs per year	**879,600**

Source: GIZ/MSPL

11.4 Long term investment plan

The long term investment and reinvestment plan for 2019-2020 is presented in the table below.

Table 11-14: Investement and reinvestement plant, 2019-2040 (1,000 Euro)

		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Donduseni Rayon																							
Landfill Donduseni (including TS for recyclable)	Construction works and buildings	814,7	2.963,2	0,0	0,0	0,0	115,2	2.158,6	0,0	0,0	0,0	101,8	1.666,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Machinery and equipment	0,0	488,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Composting plant Donduseni	Construction works and buildings	11,1	54,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Machinery and equipment	0,0	290,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	150,0	0,0	0,0	0,0	0,0	140,0	0,0	0,0	0,0	0,0	150,0
Collection and transport of residual waste including CDW	Containers/Bins		0,0	282,6	0,0	2,5	0,0	0,0	0,0	0,0	257,4	0,0	2,2	0,0	0,0	0,0	0,0	241,9	0,0	1,9	0,0	0,0	0,0
	Vehicles		0,0	329,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	329,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Separate collection and transport of recyclable waste	Containers		0,0	36,6	0,6	5,9	1,1	1,0	1,0	0,3	40,2	1,0	5,9	1,3	1,3	1,1	0,6	40,3	1,3	6,4	1,4	1,6	1,6
	Vehicles		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Briceni Rayon																							
Transfer station Briceni	Construction works and buildings	82,5	309,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	51,2	0,0	0,0	0,0	0,0	0,0
	Machinery and equipment	0,0	230,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	230,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	230,2
Collection and transport of residual waste including CDW	Containers/Bins		0,0	513,9	6,9	0,0	0,0	0,0	0,0	0,0	466,4	6,3	0,0	0,0	0,0	0,0	0,0	437,9	5,9	0,0	0,0	0,0	0,0
	Vehicles		0,0	589,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	459,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Separate collection and transport of recyclable waste	Containers		0,0	67,0	1,8	11,0	1,6	1,9	1,9	0,5	73,5	2,2	11,5	1,9	2,1	2,4	1,0	74,0	2,7	12,3	2,4	2,6	3,0
	Vehicles		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Edinet Rayon																							
Transfer station Edinet	Construction works and buildings	107,0	337,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	51,8	0,0	0,0	0,0	0,0	0,0
	Machinery and equipment	0,0	248,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	248,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	248,2
Sorting plant Edinet	Construction works and buildings	11,6	511,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Machinery and equipment	0,0	392,9	0,0	0,0	0,0	0,0	18,0	0,0	0,0	0,0	0,0	103,0	0,0	0,0	0,0	0,0	307,9	0,0	0,0	0,0	0,0	18,0
Collection and transport of residual waste including CDW	Containers/Bins		0,0	263,7	0,0	223,5	14,0	0,0	0,0	0,0	233,3	0,0	215,9	11,9	0,0	0,0	0,0	214,9	0,0	208,3	10,3	0,0	0,0
	Vehicles		0,0	459,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	459,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Separate collection and transport of recyclable waste	Containers		0,0	79,1	1,4	12,0	2,2	2,1	2,2	0,2	86,2	1,9	12,5	2,7	2,6	2,7	0,6	86,6	2,4	13,3	3,2	3,5	3,2
	Vehicles		0,0	130,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	130,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ocnita Rayon																							
Collection and transport of residual waste including CDW	Containers/Bins		0,0	263,7	0,0	0,0	84,1	0,0	0,0	0,0	239,2	0,0	0,0	80,3	0,0	0,0	0,0	224,8	0,0	0,0	75,6	0,0	0,0
	Vehicles		0,0	459,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	459,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Separate collection and transport of recyclable waste	Containers		0,0	50,6	1,4	7,5	1,4	1,4	1,4	0,2	55,2	1,6	7,8	1,6	1,8	1,9	0,3	55,6	2,1	8,3	2,1	2,2	1,9
	Vehicles		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
WMZ 8																							
Waste facilities	**Construction works and buildings**	**1.026,9**	**4.175,9**	**0,0**	**0,0**	**0,0**	**115,2**	**2.158,6**	**0,0**	**0,0**	**0,0**	**101,8**	**1.666,9**	**0,0**	**0,0**	**0,0**	**0,0**	**103,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**
	Machinery and equipment	**0,0**	**1.650,0**	**0,0**	**0,0**	**0,0**	**0,0**	**18,0**	**0,0**	**0,0**	**0,0**	**0,0**	**731,4**	**0,0**	**0,0**	**0,0**	**0,0**	**447,9**	**0,0**	**0,0**	**0,0**	**0,0**	**646,4**
Waste collection and trasport	**Equipment for waste collection an**	**0,0**	**0,0**	**3.523,2**	**12,2**	**262,4**	**104,4**	**6,4**	**6,6**	**1,1**	**1.451,4**	**13,1**	**255,8**	**1.935,8**	**7,7**	**8,2**	**2,6**	**1.375,9**	**14,4**	**250,4**	**95,0**	**9,9**	**9,8**
Supervision	**Construction supervision**	**137,1**	**548,2**	**0,0**	**0,0**	**0,0**	**45,5**	**181,9**	**0,0**	**0,0**	**0,0**	**35,4**	**141,5**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**
Contingencies	**Contingecies**	**102,7**	**582,6**	**0,0**	**0,0**	**0,0**	**11,5**	**217,7**	**0,0**	**0,0**	**0,0**	**10,2**	**239,8**	**0,0**	**0,0**	**0,0**	**0,0**	**55,1**	**0,0**	**0,0**	**0,0**	**0,0**	**64,6**

Source: GIZ/MSPL

12 Financial and economic analysis

The objective of the Financial and Economic Analysis (Cost Benefit Analysis-CBA) was to assess the financial and economic viability and sustainability of the Project over the entire project lifetime.
The CBA has considered all relevant data and information made available from the various sources and especially the reports, financial statements and operational/ demand/ O&M data provided by the local stakeholders. It takes further into account the socioeconomic data, background information, technical concepts, demand projections and cost estimates, as detailed in the respective chapters of the Feasibility Study.

The Financial and Economic Analysis (CBA) has taken into account all the relevant existing guidance for preparing the analysis:

- The requirements laid down in the Term of Reference for the present project;
- "Guide to Cost-Benefit Analysis of Investment Projects. Economic Appraisal Tool for Cohesion Policy 2014-2020", Issued by the European Commission in December 2014;
- "COMMISSION IMPLEMENTING REGULATION (EU) 2015/207 laying down detailed rules implementing Regulation (EU) No 1303/2013 of the European Parliament and of the Council as regards the models for the progress report, submission of the information on a major project, the joint action plan, the implementation reports for the Investment for growth and jobs goal, the management declaration, the audit strategy, the audit opinion and the annual control report and the methodology for carrying out the cost-benefit analysis and pursuant to Regulation (EU) No 1299/2013 of the European Parliament and of the Council as regards the model for the implementation reports for the European territorial cooperation goal", Annex III;
- COMMISSION DELEGATED REGULATION (EU) No 480/2014 supplementing Regulation (EU) No. 1303/2013 of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund, Section III.

According to EU standards the CBA, and thus also the financial and economic analysis has to use the "incremental method": that means, the project is evaluated on the basis of the differences between the scenario "with the project" and an alternative scenario "without the project". For the "With Project" scenario, the cost and revenues considered must be those of a scenario of efficient operation. For the "Without Project" scenario, the cost and revenues considered are those of a "business as usual" without any major new investments or replacements.
The financial analysis contains the following components:

- Projection of basic project relevant development data:
  - Population;
  - Service levels;

- Waste generation;
- Waste collection;
- Recycled waste;
- Composted waste, as estimated in the Feasibility Study for the period 2016 –
- 2046, estimate and projection of corresponding development data for the
- "without project case".

- Projection and allocation of overall investment and reinvestment cost for the proposed
- waste project measures and cost of additional further investment measures required; as estimated in the Feasibility Study for the period 2016 – 2046;
- Projection of annual O&M cost as required for adequate operation and maintenance of the proposed solid waste management system, to assure the envisaged service standards and the full technical lifetimes of the investment under the prevailing conditions in the study area; as estimated in the Feasibility Study for the period 2016 –2046; estimate and projection of appropriate annual O&M cost for the "without project case";
- Tariff strategy for the development of appropriate solid waste tariffs, taking into account both full cost coverage and affordability issues; appropriate assumptions for tariff development in the "without project case";
- Projection of revenues from waste collection and treatment services to the connected domestic and non-domestic customers in the project area for both "with project case" and "without project case";
- Projection of the financial performance of the future potential operator over the evaluation period 2016 to 2046;
- Elaboration of an appropriate Financing Plan.

The financial and economic analysis is based on the data of the base year 2015 and is carried out for the period 2016 to 2046 which comprises the envisaged project implementation period 2019 to 2021 and an operation period of 26 years from 2020 to 2046.

12.1 Investment costs

12.1.1 Investment costs

The investments within the project shall be realized during 4 years – during 2018, when there will be made the design expenditures, and during 2019-2021, when the investments in construction will be made and equipment, tools and vehicles required for service initiation will be purchased.
Such investments include only expenditures for the initial stage of the project, but the reinvestment costs are specified in the CBA Financial Mode "Reinvestments" (Sheet "Investments"). The initially required amount of investments and schedule thereof are presented in the table below.

Table 12-1: Breakdown of project investment costs

		Total	**2018**	2019	2020	2021
Residual Waste Collection Investment	EUR	3,159,908	**-**	-	-	3,159,908
Separate Waste Collection Investment	EUR	363,303		-	-	363,303
Briceni specific investment	EUR	621,940		82,535	539,405	-
Donduseni specific investment	EUR	4,621,649		825,795	3,795,854	-
Edinet specific investment	EUR	1,609,238		118,580	1,490,658	-
Other overheads	EUR	1,590,000	**400,000**	638,000	552,000	-
Contingency	EUR	685,283		102,691	582,592	-
Total		**12,651,320**	**400,000**	**1,767,601**	**6,960,509**	**3,523,211**
Investment implementation shedulling			3.2%	14.0%	55.0%	27.8%

Source: GIZ/MSPL

All Project investment costs as determined in the Feasibility Study are considered as eligible cost for financing support. The detailed calculation and scheduling of the investments costs are presented in the CBA Financial Model, Sheet “Investments”. The investments for Ocnita have integrated with those for the system, and there are no specific investments.

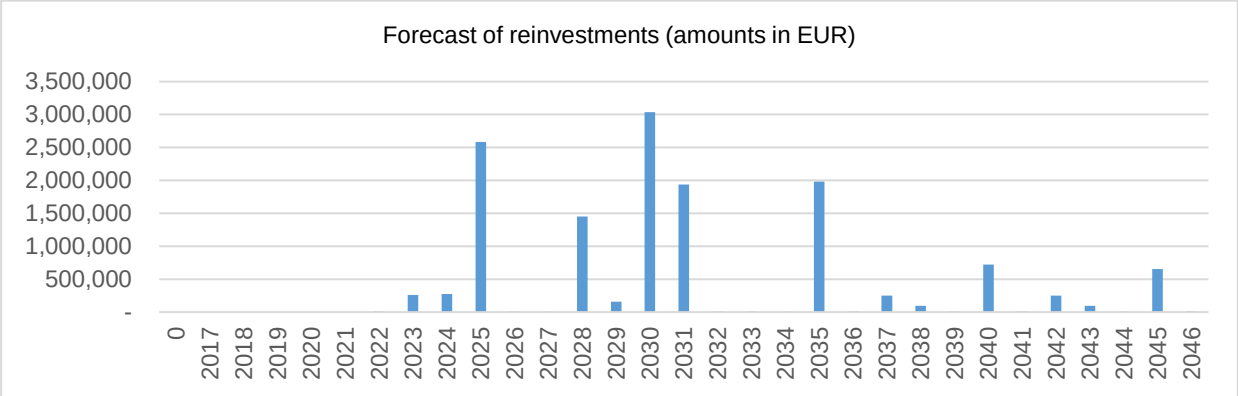
12.1.2 Replacement costs

The reinvestment costs for the tools and/or equipment with a shorter service life have been calculated for the project duration too, in order to maintain the service management capacity. The reinvestment costs have been calculated for the following categories:

- Residual Waste Collection Investment
- Separate Waste Collection Investment
- Briceni specific investment
- Donduseni specific investment
- Edinet specific investment
- Other overheads
- Contingencies

The reinvestment categories have been calculated for the period of 2022-2046, when the value thereof will make circa 13,855.6 thousand EUR. The detailed forecast of the level of reinvestment costs over the years is presented in the following figure.

Figure 12-1: Forecast of reinvestment costs (amounts in EUR)



Source: GIZ/MSPL

The detailed calculation and scheduling of the investments costs are presented in the CBA Financial Model, Sheet “Investments”.

12.1.3 Residual value

The residual value reflects the capacity of the remaining service potential of the fixed assets whose economic life is not yet completely exhausted. Thus, for projects assets with economic lifetime in excess of reference period, their residual value shall be determined by computing the net present value of cash flow in the remaining life years of the operation (according to the CBU Guide).
For the present analysis, we have calculated the residual value considering the discounted cash flow for the remaining life of assets by considering the cash flow from the last year of forecast (year 2046). The residual value of the investment will differ for each scenario analysis considering the affordability principle that will be used.
The detailed calculation of the residual value is presented in the CBA Financial Model, Sheet “Investments”.

12.2 Operating costs

12.2.1 Operating costs – “With project scenario”

The operating costs have been calculated taking into account two conditions: costs of the existing waste management systems, recorded in 2014-2016 and used to estimate the costs before commissioning of the new system in 2017-2020. Such costs will serve further as a basis for calculation of the “Without project” scenario.
The O&M costs are based on the O&M costs presented by the waste management companies for 2014-2016 (in MDL and then calculated in EUR, depending on the average exchange rate) and on the forecast of such costs before the new system will be commissioned in 2021.
In the following table we will present the costs for the existing system up to 2020, the moment when the system will be replaced.

Table 12-2: Operating costs forecast (2017-2020) – “With Project” Scenario

Operating Costs for Existing System (EUR)	2017	2018	2019	2020
Salaries	109,518	111,325	113,162	115,199
Social insurance	29,444	29,929	30,423	30,971
Gas	38,661	39,048	39,439	39,833
Spare parts	8,049	8,130	8,211	8,293
Depreciation	25,542	25,797	26,055	26,316
Other direct expenditures	25,289	25,542	25,797	26,055
General and administrative expenditures	65,105	65,756	66,414	67,078
Other activities operational expenditure	149	150	152	153
Existing system costs	**301,757**	**305,678**	**309,653**	**313,898**

Source: GIZ/MSPL

Costs of the existing systems before construction of a new system will evolve from 301.7 thousand EUR in 2017 to 313.9 thousand EUR in 2020.

The operating costs for the new system have been estimated in EUR, starting with 2021, in conformity with technical calculations of the system for the period of 2021-2046 (constant costs).

Table 12-3: Operating costs forecast – collection costs (2019-2046) (amounts in EUR) – "With Project" Scenario

Operating collection costs for the proposed system (EUR)	2021	2026	2031	2036	2041	2046
Residual Collection Costs						
Personnel costs	189,144	231,022	241,527	257,429	277,502	303,392
Fuel costs	158,290	174,781	164,891	157,847	154,204	162,070
Other consumables	15,829	17,478	16,489	15,785	15,420	16,207
Maintenance	158,929	202,635	187,141	182,717	183,294	192,644
Other costs (administration 10%, unscheduled services 5%)	99,188	121,442	117,011	116,935	119,273	125,357
Insurance	27,405	35,837	33,010	32,225	32,400	34,053
Recyclables Collection Costs						
Personnel costs	24,333	40,616	48,987	54,086	59,598	65,158
Fuel costs	20,066	30,197	33,331	34,128	35,284	37,084
Other consumables	401	604	667	683	706	742
Maintenance	13,159	17,673	18,616	18,872	19,334	20,320
Other costs (administration 10%, unscheduled services 5%)	16,804	25,232	28,312	29,734	31,346	32,945
Insurance	3,170	4,376	4,647	4,724	4,853	5,101
Home composting (The cost of raising awareness)	13,991	16,937	20,529	25,032	25,032	25,032
Total collection costs	740,710	918,831	915,157	930,197	958,247	1,020,106

Source: GIZ/MSPL

The forecast of the operating costs related to the transfer, processing and disposal activities are presented synthetically in the following table:

Table 12-4: Operating costs forecast –transfer and processing costs (2021-2046) (EUR)

Operating transfer and processing costs for the proposed system (EUR)	2021	2026	2031	2036	2041	2046
DONDUSENI OPERATION						
Personnel	35,600	39,651	37,624	36,106	35,641	38,967
Consumables	349,858	387,922	366,862	351,167	344,820	371,469
Admin	51,493	60,658	60,324	58,603	57,923	60,877
Taxes	22,657	26,689	26,543	25,785	25,486	26,786
Maintenance	129,472	179,003	198,756	198,756	200,743	210,983
EDINET OPERATION						
Personnel	61,600	86,863	93,140	94,332	97,385	106,471
Consumables	48,888	63,802	66,020	65,877	67,003	72,182
Admin	17,503	22,714	23,564	23,669	24,054	25,281
Taxes	7,701	9,994	10,368	10,414	10,584	11,123
Maintenance	64,539	76,479	76,479	76,479	77,244	81,184
BRICENI OPERATION						
Personnel	15,200	17,319	16,650	16,069	15,940	17,427
Consumables	37,576	42,815	41,160	39,725	39,289	42,326
Admin	7,889	9,108	8,875	8,674	8,616	9,056
Taxes	3,471	4,007	3,905	3,816	3,791	3,985
Maintenance	26,112	30,943	30,943	30,943	31,252	32,846
Total transfer and processing costs	**879,559**	**1,057,968**	**1,061,212**	**1,040,415**	**1,039,771**	**1,110,962**

Source: GIZ/MSPL

The total operating costs of the proposed system are presented in the table below, comprising both the collection and the transfer and processing costs.

Table 12-5: Total operating costs forecast (2019-2046) (EUR), "With Project" scenario

Operating Collection Costs for Proposed system (EUR)	2021	2026	2031	2036	2041	2046
Collection costs	740,710	918,831	915,157	930,197	958,247	1,020,106
Transfer and processing costs	879,559	1,057,968	1,061,212	1,040,415	1,039,771	1,110,962
Total collection costs	1,620,269	1,976,799	1,976,369	1,970,612	1,998,018	2,131,067

Source: GIZ/MSPL

The total costs of the new waste management system have been estimated as evolving from 1,620.3 thousand EUR in 2017 to 2,131.1 thousand EUR in 2046.

12.2.2 Operating costs – "Without project scenario

The O&M costs for the "Without project "scenario within the CBA have been calculated relying on the existing operating costs of the waste management operators in the operational zones projected for the whole normal service life of the project, i.e. till 2046. Such costs have been adjusted subject to the factors of growth of the prices for materials, personnel costs, fuel costs and energy costs. This is the abovementioned approach – "business as usual", without foreseeing any new major investments or replacements but keeping the same operational structure.

The forecast of the operating costs for the without project scenario is presented in the table below.

Table 12-6: Operating costs forecast (2017-2046) (EUR), "Without Project" scenario

Operating Costs for Existing System (EUR)	2017	2021	2026	2031	2036	2041	2046
Salaries	109,518	117,272	128,214	140,176	153,254	167,553	183,185
Social insurance	29,444	31,528	34,470	37,686	41,202	45,046	49,249
Gas	38,661	40,231	42,284	44,440	46,707	49,090	51,594
Spare parts	8,049	8,376	8,803	9,252	9,724	10,220	10,742
Depreciation	25,542	26,055	26,055	26,055	26,055	26,055	26,055
Other direct expenditures	25,289	26,316	27,658	29,069	30,552	32,110	33,748
General and administrative expenditures	65,105	67,749	71,205	74,837	78,654	82,667	86,883
Other activities operational expenditure	149	155	162	171	179	189	198
Total operating costs	**301,757**	**317,682**	**338,851**	**361,686**	**386,329**	**412,929**	**441,654**

Source: GIZ/MSPL

It can be seen that the costs in the without project scenario will increase from 301.7 thousand EUR in 2015 to 441.6 thousand EUR in 2046.

12.3 Tariff setting

The tariff system proposed for the "With project" scenario will suggest applying a unique tariff within the entire project zone. At the same time, there will be two unique tariffs for the zone, to be applied to:

- Population, public institutions, small businesses, and
- Users – large businesses and producers.

- The tariffs have been calculated taking into account the following hypotheses:
  - Cost recovery shall be guaranteed,
  - The tariffs shall be accessible.

In practice the method adopted for estimating suitable tariffs was the following:

- Calculate the theoretical full cost-covering tariff for the waste management system by the levelised unit cost' (LUC) method, also referred to as the dynamic prime cost (DPC) method. This involves taking the discounted value of all the net costs of the system (disregarding tariffs) over the reference period – investments, replacement investments, O&M costs less income earned from sale of recyclable waste and compost – and dividing this by the discounted tonnes of waste collected over the reference period. The discounted value of all the net costs is in fact corrected for the residual values of the existing assets at the start and the investments at the end of the reference period, and the costs of fixing historical problems (i.e. closing existing landfills) are not included. The index so obtained (units €/tonne) is in fact the full cost-covering tariff which should be achieved by the waste management system as soon as is feasible. The calculation of the LUC is carried out in the sheet "Revenues" from the financial model;
- The tariffs charged to households are increased up to the LUC level as soon as possible, having regard to constraints of affordability and financial sustainability. The regard to affordability was that a household should never pay more than 1% of its revenues for solid waste management (best practice threshold). This level was calculated starting from data gathered from statistical sources.
- The tariff for non-households (Similar (institutions and commercial companies, Park/garden, Other (street waste, bulky, waste from markets)) has been calculated as "Full recovery cost" i.e. this cost applied for the demand as a whole will allow to recover the investments.

It was considered that the suitable approach would be to apply systematically the affordable tariff and to always compare it with the DPC calculated in order to ensure long term sustainability.

The results of the DPC (LUC) calculation are presented in the following table.

Table 12-7: Dynamic Prime Costs (DPC) calculation

DPC Calculation	Unit	NPV@4%
Discount rate		4.0 %
Residual value of existing assets (estimation)	EUR	2,928,848
Investment Cost Total	EUR	12,651,320
Reinvestments	EUR	13,855,588
Residual value of investments	EUR	-
OM&A Cost	EUR	52,145,533
Revenues from recyclables and compost	EUR	(16,012,963)
Total Cost (Inv+O&M)	**EUR**	**65,568,327**
Total Waste input into system	**tonne/year**	**984,567**
DPC, Investment	**EUR/tonne**	**29.90**
DPC, OM&A	**EUR/tonne**	**36.70**
DPC, Total	**EUR/tonne**	**66.60**

Source: GIZ/MSPL

According to this approach, a full cost recovery tariff on long-term is around 66.06 EUR/tonne.

When it comes to the second approach based on the ability of the household consumers to pay on the domestic market, we have considered an accessibility rate of 1.0% for the whole period under analysis (we have presupposed that an average household will pay 1.0% of their household incomes per solid waste bill) as a basic scenario at the first stage. Meanwhile, we have calculated several tariff levels in order to model several project financing scenarios. That has been done to show the financing and investment recovery options at different tariff levels and, as well, to analyse tariff supportability by the population.

Table 12-8: Affordable tariff levels

Affordability principle	Tariff paid by population			Tariff paid by non-households (Similar, Park/garden, Other (street waste, bulky, waste from markets))
%	EUR/t	MDL/pers./month - urban	MDL/pers./month - rural	EUR/t
1.00%	51.00	15.27	12.22	73.90
1.10%	56.10	16.80	13.44	
1.15%	58.65	17.56	14.05	
1.20%	61.20	18.33	14.66	
1.25%	72.93	24.77	19.82	

Source: GIZ/MSPL

The analysis shows that the accessible tariff will not have covered the DPC till 2042, however, it will be compensated after the accessible tariff exceeds the DPC. Meanwhile, the tariffs paid by non-households users (the amount generated by them has been calculated as total amount generated by this institutions and that will compensate for a part of the tariff paid by the population. As a consequence, it will ensure long-term durability and accessibility of the tariff proposed. As we can notice, the Tariff paid by Similar (institutions and commercial companies) – big makes 73.9 EUR/tonne, this corresponding to the level of 1.26% of the population incomes (% of the revenues ensuring full payback of the project).
Sustainability will be highlighted in the financial situations presented in the following chapters of this report.
The tariff proposed for the "Without project" scenario is set based on the operating costs of the "Without project" scenario and on the amounts of this scenario. Besides the tariff covering the costs, there has been added a 10% profit margin to ensure operational durability in this case.

12.4 Project revenues

12.4.1 Project revenues – "With project" scenario

The project recognizes three types of revenues: revenues from collection, revenues from compost and revenues from recycling.
The estimate of the collection operation revenues are performed considering the demand forecast for the "With Project" scenario and the proposed tariff scenario presented in the previous chapters.
The revenues from collection activity are presented in the following table, based on the demand forecast and tariff forecast presented in the previous chapters.

Table 12-9: Revenues form collection – "With Project" scenario

Revenues from collection (EUR)	2017	2021	2026	2031	2036	2041	2046
Household	206,736	1,879,684	1,840,539	1,801,291	1,796,616	1,816,594	1,918,730
Similar (institutions and commercial companies)	49,573	350,568	345,806	341,591	344,729	352,370	372,181
Park/garden	19,267	70,351	69,396	68,550	69,180	70,713	74,689
Other (street waste, bulky, waste from markets)	20,385	93,085	91,820	90,701	91,534	93,563	98,824
Total collection revenues	**295,961**	**2,393,688**	**2,347,560**	**2,302,133**	**2,302,060**	**2,333,241**	**2,464,423**

Source: GIZ/MSPL

It can be seen that the collection revenues increase from 295.9 thousand EUR in 2017 to 2,464.4.4 thousand EUR in 2046.

The revenues obtained from the compost and recyclables sales activities have been determined using the amounts produced as a result of composting activities, provided by the technical team and presented in the Feasibility Study Section (Sheet "Demand forecast"), and, as well, using the minimum price assessed in the Moldovan market.

The table below highlights the revenues from recyclables and compost for the "With Project" scenario.

Table 12-10: Revenues from recyclables and compost, "With Project" scenario

Revenues from compost and recyclables (EUR)	2017	2021	2026	2031	2036	2041	2046
Plastic	-	142,015	182,719	186,067	190,617	195,051	195,051
Paper and cardboard	-	79,708	95,730	103,928	106,470	108,946	108,946
Glass	-	11,046	14,211	14,472	14,826	15,171	15,171
Metal	-	185,664	266,821	331,359	339,461	347,357	347,357
Revenues from compost	-	1,953	1,889	1,830	1,784	1,754	1,754
Income from other activities	3,324	-	-	-	-	-	-
Total compost and recyclables revenues	**3,324**	**420,385**	**561,372**	**637,656**	**653,158**	**668,279**	**668,279**

Source: GIZ/MSPL

The total revenues are presented in the following table for the projection period.

Table 12-11: Total revenues – "With Project" scenario

Total revenues (EUR)	2017	2021	2026	2031	2036	2041	2046
Revenues from collection	295,961	2,393,688	2,347,560	2,302,133	2,302,060	2,333,241	2,464,423
Revenues from recyclables and compost	3,324	420,385	561,372	637,656	653,158	668,279	668,279
Total collection revenues	299,285	2,814,074	2,908,932	2,939,789	2,955,217	3,001,519	3,132,702

Source: GIZ/MSPL

It can be seen that the total revenues for the "With Project" scenario increase from 299.3 thousand EUR in 2017 to 3,132.7 thousand EUR in 2046.

12.4.2 Project revenues – "Without project" scenario

The forecast for the revenues of the "Without project" scenario is based on the same hypotheses as the "With project" scenario. The demand for the waste amounts to be collected is multiplied by the average tariff of the existing systems. There are no composting or recycling revenues and the only revenues as such are generated by the collection activities.
The revenues from collection activities for the "Without project" scenario are presented below.

Table 12-12: Total revenues – "Without Project" scenario

Revenues from collection (EUR)	2017	2021	2026	2031	2036	2041	2046
Household	206,736	217,953	232,885	249,029	266,490	285,381	305,826
Similar (institutions and commercial companies)	49,573	52,263	55,844	59,715	63,902	68,432	73,334
Park/garden	19,267	20,312	21,703	23,208	24,835	26,596	28,501
Other (street waste, bulky, waste from markets)	20,385	21,491	22,963	24,555	26,277	28,139	30,155
Total collection revenues	295,961	312,019	333,395	356,507	381,504	408,548	437,816

Source: GIZ/MSPL

It can be seen that the total revenues for the "without project" scenario increase from 295.9 thousand EUR in 2017 to 437.8 thousand EUR in 2046.

12.5 Project potential grant intervention level

The financing structure of the project and any potential needed grant intervention level was calculated considering the funding gap method from the European Cost Benefit Analysis Guide for investment projects. All issues related to "Grant Intervention Level" are determined and calculated with the Excel CBA model, sheet "Funding Gap".
As according to EU standards the CBA has to use the "incremental method" all data are stated as far as relevant separately for the "With Project Case", the "Without Project Case" and as "incremental data".
The cost and revenue figures related to grant Intervention are stated in real EUR.

12.5.1 Financing gap

The financing gap is calculated based on the methodology as provided by the "Guide to Cost-Benefit Analysis of Investment Projects. Economic Appraisal Tool for Cohesion Policy 2014-2020", issued by the European Commission in December 2014.
According to "Commission Regulation Implementing Regulation 2015/2007, Annex III, "Methodology for carrying out the cost-benefit analysis" it is mentioned that "the

determination of the level of grant is based on the "funding gap" rate of the project, i.e. "the share of the discounted cost of the initial investment not covered by the discounted net revenue of the project". This implies an exclusion of the Working Capital and Replacement Cost as part of the Discounted Investment Cost (DIC) in the funding gap calculation. The residual value of the investment at the end of the analysis period is treated as revenue in the calculation of the Discounted Net Revenue (DNR). This confirms that some „investment related" cost can be excluded of the DIC calculation and considered instead as cash-flow contribution to the DNR.

More over in that particular example, the DIC calculation is based on the total project investment and not the eligible investment component only. This implies that recognized ineligible investment costs can be included in the value of the DIC in the calculation of the funding gap.

The calculation of the financing gap is performed in sheet "Funding Gap" and presented in the table below.

Moreover, the DIC calculations are based on the whole project in this particular example. Investments but not only the composition eligible for investments. This implies that recognised ineligible investment costs can be included in the DIC value in the calculation of financing difference.

Financing difference is calculated in the Sheet "Funding Gap" and is presented in the table below.

Table 12-13: Funding gap calculation (potential grant intervention level)

Funding Gap Calculation	**Unit**	**NPV@4.0%**
Calculation of Discounted Investment Cost (DIC)		
Investment cost (w/o contingencies)	EUR	10,197,614
Non-eligible investment cost (w/o contingencies)	EUR	-
DISCOUNTED INVESTMENT COST (DIC)	**EUR**	**10,197,614**
Calculation of Discounted Net Revenues (DNR)		**NPV@4.0%**
Revenues	EUR	35,202,663
O&M costs	EUR	(21,308,838)
Decrease / (Increase) in working capital	EUR	(908,651)
Replacement costs	EUR	(7,800,264)
Residual value of investments	EUR	1,362,183
Income tax on operations	EUR	(2,214,366)
DISCOUNTED NET REVENUES (DNR)	**EUR**	**4,332,727**
ELIGIBLE COST (EC, from project cost table):	EUR	12,651,320
PRO-RATA OF ELIGIBLE EXPENDITURES	%	100.00%
ELIGIBLE EXPENDITURE (EE = DIC-DNR):		12,651,320
FUNDING GAP RATE (R = EE / DIC):		**57.51%**

Source: GIZ/MSPL

The level of the financing gap calculated with a discount rate of 4% and considering an affordability limit of 1.0% for the average household is 57.51%. Under this assumptions and results, the financing structure of the project is the presented in the following table.

Table 12-14: Potential financing structure of the investment project

Total value of the project (Total cost = eligible + ineligible costs)	Eligible cost	Funding Gap (grant level)			
12,651,320	12,651,320	7,275,774.1			
100.0%	100.00%	57.51%	of 1.1		
	of 1				
		Non Funding Gap (debt level)			
		5,375,546			
		42.49%	of 1.1		
	Ineligible cost (others categories than eligible)	Operator or local authorities		VAT	Reclaimed
					0
		0		0	n/a
	0	n/a	of 1.2	n/a	Nonreclaimed
	0.00%				0
	of 1				n/a
				Noneligible	
				0	
				n/a	

Source: GIZ/MSPL

Covering/reimbursement of "Non Funding Gap" (debt level) has been calculated as a credit with a financing value, contracted for a 20-year period under the following conditions:

Table 12-15: Conditions of initial credit granting

Financing period	20 years	
Credit Grace Period	2017-2021 – or a period of time from the first withdrawal till commencement of activities and receipt of the first revenues.	
Disbursement	5,375,546	
Repayment	268,777	Annually – fixed rate
Interest	1,5%	Annually

Source: GIZ/MSPL

12.5.1.1 Credit reimbursement capacity

To analyse the capacity to repay the requested credit, we will examine the future flows from the perspective of coverage of the required resources on the account of own activities for the purpose of payment of the annual rates, initial credit, additional credits and interests thereon.
To analyse the capacity to repay, we will have to consider the following indicators:
To analyse the capacity to repay the credits, we have chosen the EBITDA indicator that is an abbreviation of Earnings Before Interest, Taxes, Depreciation and Amortisation. This indicator shows how much money is generated by a company as a result of its current activities before repaying the debts and taxes and reflecting the non-cash expenditures (amortisation). The calculation formula is the following:
EBITDA = net revenue + interest costs + tax costs + amortisation costs

Table 12-16: The ability to repay the loan (2021-2040)

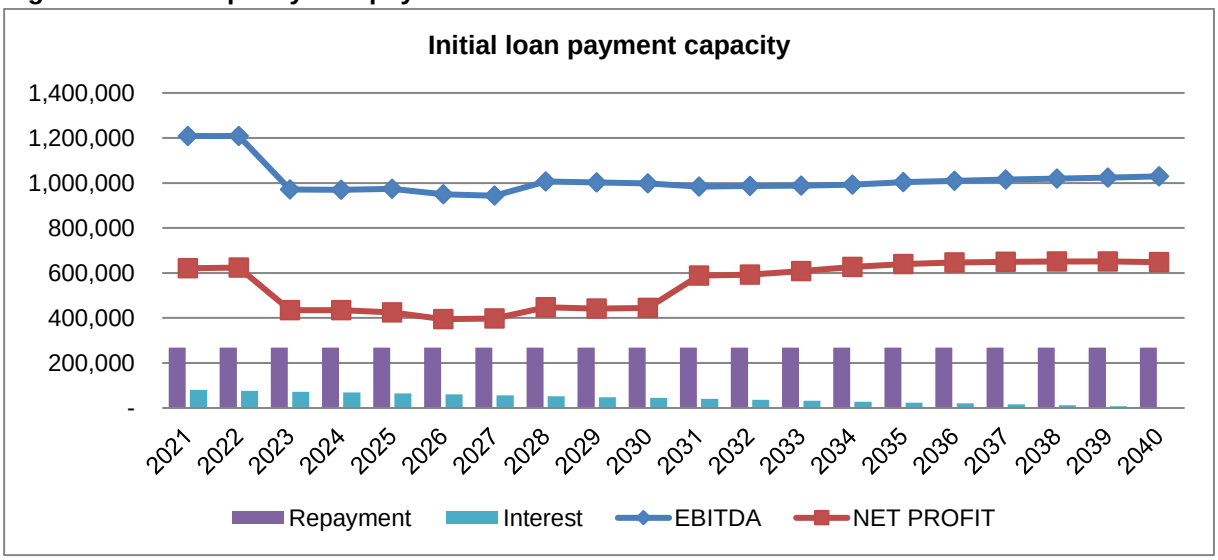
	2021	2026	2031	2036	2040	Total
EBITDA	1,207,796	949,070	983,949	1,009,637	1,028,664	20,280,089
NET PROFIT	620,294	394,681	588,315	647,209	648,432	10,966,213
Co-financing loan - initial investment						-
Repayment	268,777	268,777	268,777	268,777	268,777	5,375,546
Interest	80,633	60,475	40,317	20,158	4,032	846,648
Other financing loans - reinvestments						-
Repayment	-	313,383	778,870	1,117,348	750,162	11,111,430
Interest	-	43,449	96,107	68,537	25,778	923,891
The difference from EBITDA and Payments for credits	**858,385**	**262,985**	**(200,122)**	**(465,184)**	**(20,085)**	**2,022,573**

Source: GIZ/MSPL

Relying on the future revenues forecasts and profit and loss statements, we have obtained the results shown in the table above. We can notice that the cumulative value of the net revenue for 2021-2040 makes 10,966.2 thousand EUR and the EBITDA value for the same period is 20,280.1 thousand EUR. The value of total credit reimbursements makes 18,257.52 thousand EUR for this period. This shows that the enterprise may fulfil its duties with regard to the credits obtained. The value of payments will be higher than the EBITDA value during the period of 2031-2039, and this will be caused by continuous reinvestments taking place during the previous years. Such reinvestments will be covered due to the previous-years cash flows and short-term credits, or another option will be a short-term aid granted by the local and central public authorities.

The schedule below presents the initial credit repayment capacity.

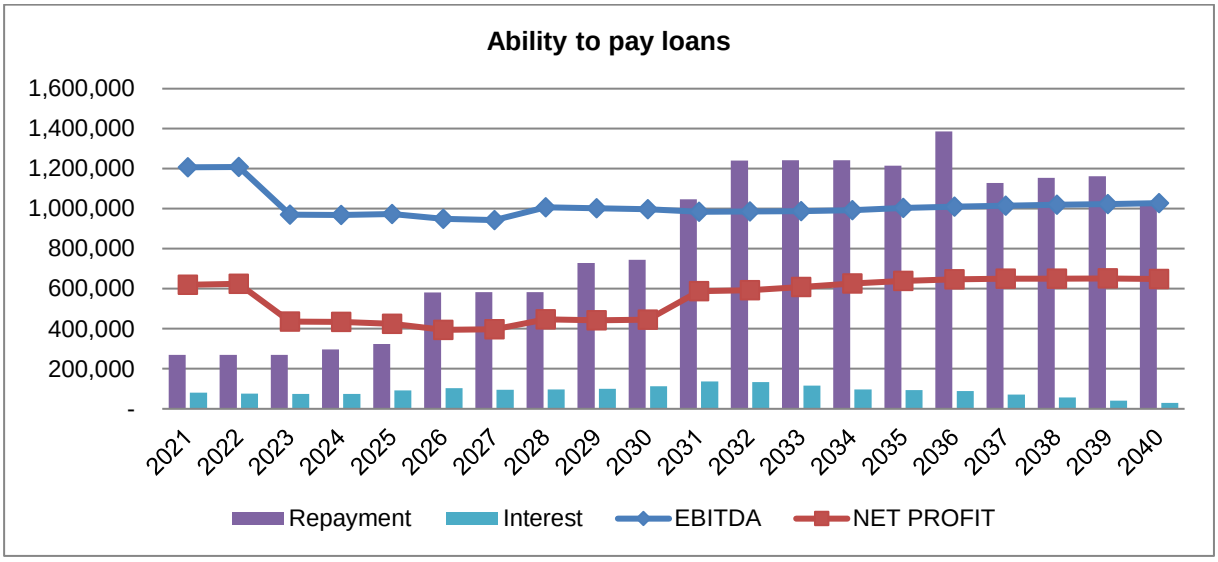
Figure 12-2: Capacity to repay the initial credit



Source: GIZ/MSPL

The dynamics of payments on the obtained credits and capacity to repay them is presented in the schedule below.

Figure 12-3: Capacity to pay all credits



Source: GIZ/MSPL

12.5.2 The net present value and the rates of return with and without grant assistance

The Financial Net Present Value on costs (FRR/C) and the Internal Rate of Return on costs (FRR/C) before grant intervention level and the Financial Net Present Value on capital (FRR/k) and the Internal Rate of Return on capital (FRR/K) after the grant intervention level is presented in the following table.

Table 12-17: Financial performance indicators of the investment project

Main Elements and Parameters	Before Grant		After Grant	
Financial rate of return (%)	-0.64%	FRR/C	1.02%	FRR/K
Net present value	(6,454,180)	(FNPV/C)	(968,908)	(FNPV/K)

Source: GIZ/MSPL

According to the calculations, the indicator FRR/K is at the limit recommended by the European Commission – 8%.

12.6 Financial statements

In order to assess the long-term sustainability of the future operator of the Project Investment, the Consultant has elaborated the following financial statements in constant Euro:

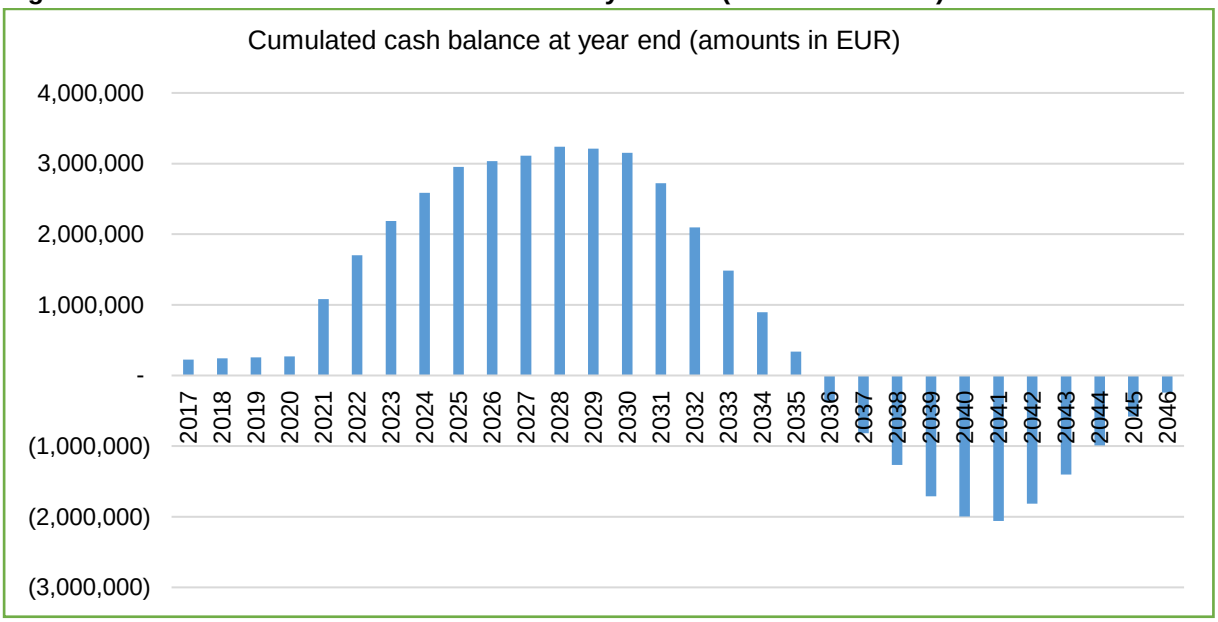
- Balance Sheet: The Balance Sheet of the future operator for the period 2017 to 2046 is presented in constant prices (Euro), with the following simplified structure:
  - Total assets;
  - Net fixed assets;
  - Current assets;

- Total Equity and Liabilities;
- Equity;
- Liabilities.

- Income Statement: The Income Statement of the Operator for the period 2014 to 2046 is presented in constant prices (Euro) in Annexes of the CBA, with the following simplified structure:
  - Revenues;
  - Operating expenditures;
  - EBITDA;
  - EBIT;
  - EBT;
  - Net income.
- Cash Flow Statement: The Cash Flow Statement of the Operator for the period 2014 to 2046 is presented in constant prices (Euro) the Annexes of the CBA, with the following simplified structure:
  - Funds from operation;
  - Free cash flow;
  - Cash flow before debt service;
  - Surplus / deficit for the year;
  - Net cash flow.

The detailed forecast of the financial statements both for the "With Project" and "Without Project" scenarios are presented in the financial model, sheet "Financial Statements".

Figure 12-4: Cumulated cash flow balance at year end (amounts in EUR)



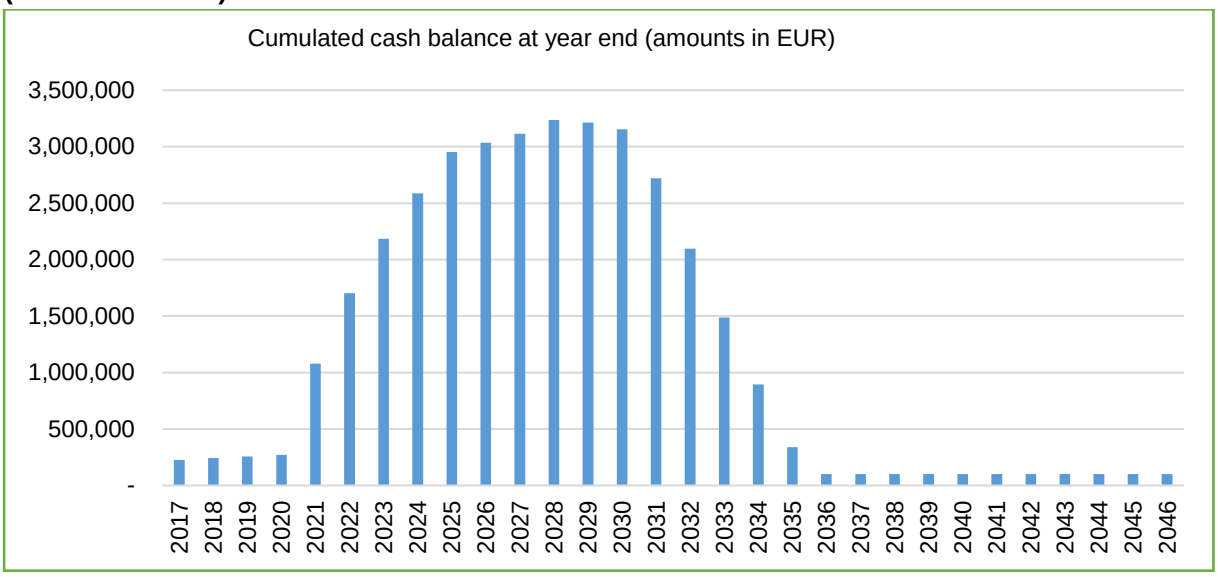
Source: GIZ/MSPL

The cash flows forecast for the "With project" scenario is positive. The cash flow is positive for the period of 2017-2031 but a short-term period of a negative cash flow will have started since 2036, due to reinvestments into replacement of some assets. To cover this cash deficit, the operator may seek for short-term loans covering the required amount of cash.
Such temporary deficits of cash flow may be financed in two ways:

- The local authorities will assume financing of a part of reinvestments on the account of investment subventions,
- The operator will conclude loan agreements for a longer period of time or will contract an additional short-term loan to cover the cash deficit.

The following chart shows the situation in which the future operator will take a credit line in order to cover the temporary cash shortages.

Figure 12-5: Cumulated cash flow balance at year end considering a temporary credit line (amounts in EUR)



Source: GIZ/MSPL

Under this scenario, the cash balance is positive in all years of analysis showing the long term sustainability of the project.

12.7 Alternative financing scenarios

The results of the basic scenario presented in the following chapters are based on the hypothesis that the accessibility rate used for analysis makes 1% for an average household (an average household will pay 1% of their incomes per solid waste bill). This scenario will lead to a need for obtaining a 59.4% grant.

However, taking into account the experience of the previous municipal infrastructure projects funded in Moldova, we may draw a conclusion that it will be very difficult to find a grantor to ensure such a high subvention percentage. The experience of the previous projects has shown that the grant level made 33% of the investment value, 50% in certain limited cases or a maximum of 66% in case of a water project funded by the EBRD.

It should be mentioned that should the grant rate be lower, then it will be necessary to increase the tariffs, in order to respect the obligations before the creditors. This means a higher tariff for household consumers.

The crediting rates for different tariff levels are presented below.

Table 12-18: Correlation between affordability ratio and debt financing

Affordability principle	Debt financing percentage of the investment costs	FRR/C	(FNPV/C)	FRR/K	(FNPV/K)
1.00%	42.49%	-0.64%	(6,454,180)	1.02%	(968,908)
1.10%	64.06%	1.17%	(4,254,529)	5.15%	283,253
1.15%	74.84%	2.01%	(3,154,703)	9.95%	909,552
1.20%	85.63%	2.82%	(2,054,877)	50.76%	1,535,413
1.25%	96.41%	3.60%	(955,052)	241.64%	2,161,713

Source: GIZ/MSPL

The best practice in the Eastern Europe mentions that a reasonable level of the affordability limit for the solid waste sector should be 1.0% of the average household disposable income. However, depending of the financing structure available for the investments, a higher pressure can be put on the customers in order to assure significant improvement of the qualities of the services and compliance with the environmental requirements.

Besides the tariffs paid by the population, there has been also calculated a special additional tariff for non-households users – "Full recovery cost" – at the limit of 1.26%, estimated as 73.90 EUR/tonne for 2021, if compared to the tariff of 58.35 EUR/tonne for household consumers with a supportability rate of 1%.

We may say based on the table below that the optimal project scenario is 1%, since it falls within the limits of the indicators recommended by the European Commission for projects financed from the structural funds, and does not exceed 8% for the FRR/K (Financial Net Present Value of the Capital). Meanwhile, there will be kept the limit for the average tariff per tonne of wastes that makes 1%.

12.8 Economic analysis

12.8.1 Methodology

As set out in Article 101 of Regulation (EU) no. 1303/2013, an economic analysis must be carried out to appraise the project's contribution to welfare. There are two main reasons why CBA is required for major projects:

- To assess whether the project is worth co-financing;
- To assess whether the project needs co-financing.

The economic analysis addresses the first task. If the project's economic net present value (ENPV) is positive, then the society (region/country) is better off with the project because its benefits exceed its costs.

For this purpose the financial project cost have to be transferred into economic cost by appropriate conversion factors and to be compared to the economic project benefits by means of a present value approach.

The assumptions and the method of calculating the economic indicators (ENPV, ERR and Cost/Benefit Ratio) is presented in the CBA Financial Model, sheet "Economic Analysis".

The economic analysis is based on the following assumptions:

- The period for the economic evaluation is 2017 to 2046;
- The base year for evaluation is 2016;
- All cost and benefit figures are stated in constant prices;
- Discount rate used for calculation of NPV is 5%.

12.8.2 Economic Project Costs

The cost components considered in the economic evaluation are:

- Project investment cost;
- Replacement cost;
- Project OM&A costs;
- CO2 emissions.

Within the economic evaluation for the Project Measure there is only one conversion factor applied. It is a conversion factor for labor cost, used to exclude the transfer payments included in labor cost (like taxes and social security payments) and to establish a shadow price for labor considering unemployment. As suggested in the "Guide to Cost-Benefit Analysis of Investment Projects. Economic Appraisal Tool for Cohesion Policy 2014-2020" (December 2014), the following factor is applied:

SW = FW*(1-u)*(1-t)
where SW = the shadow wage
W = the financial (market) wage
u = the regional unemployment rate
t = the rate of income taxation, social security payments and other relevant taxes

The conversion factor (1-u)*(1-t) is applied for all costs with a labor component for each year of the evaluation period.

According to the Consultant's estimate taxes and transfers on labor components are about 38.33% of labor cost while the unemployment rate in the Southern part of Moldova is 8.9%. The resulting shadow price of labor is 56.43%. In order to transfer financial cost into economic cost the labor cost components have to be multiplied by a factor of 0.5602.

12.8.3 Anticipated Impacts / Benefits of the Project

The project economic benefits for waste management projects can be grouped into three main categories:

- Resource cost savings;
- Reduction of visual disamenities, odours and direct health risks;
- Reduction of greenhouse gas emissions.

The specific details and suggestions for the quantification for each category are the following:

12.8.3.1 Resource cost savings

Potential resource cost savings are of two types, namely:

- The recovery of recyclable products and the production of compost and energy;
- The reduction of the total amount of waste finally going to final disposal, which extends the economic life of the landfills.

Recovery of recyclable materials

The sale values of the recyclable materials are taken as a proxy for the resource cost saving due to the recycling. The prices of recyclable materials were taken to be as shown in the respective chapter from the financial analysis.

Production of compost

As a result of the project, rural households and municipal parks will generate a compost of good quality which can be used in situ, i.e. in the gardens of the households or in the municipal parks which produced them. For the compost we have used the same revenues as used for the financial analysis.

Recovery of energy

Incineration is not proposed as a disposal technique, and it is proposed that the landfill gas collected at landfills will be flared, as its distribution and sale to energy consumers would not be economic. No energy will therefore be recovered.

Extension of life of landfills

The reduction of the total waste quantity reaching final storage, leading to the increased lifetime of the county's landfill. This cost reduction will be quantified based on the incremental waste flow that reaches the landfill (waste reaching the landfill in the scenario „without project" minus waste reaching the landfill in the scenario „with project") multiplied with the cost for storage of one tonne of waste.

12.8.3.2 The reduction of visual disamenities, odours and direct health risks

The reduction of visual disamenities, odours and direct health risks is due to:

- The elimination of uncontrolled dump sites;
- The avoidance or proper collection and treatment of waste leachate.

The quantification of these benefits was done based on:

- Increase in land values in the areas surrounding the rehabilitated dump sites (which can be estimated at a certain amount per hectare of rehabilitated dumpsite);
- Avoided cleaning costs for not having to treat impact of uncontrolled discharges of leachate and/or the cost to develop alternative water sources when applicable (which was estimated at a certain standard amount per tonne of waste either diverted from the landfill).

12.8.3.3 Reduction of greenhouse gas emissions

The reduction of greenhouse gas emissions is due to:

- The avoidance (or proper col-lection) of methane and carbon dioxide emissions, which typically account for 64% and 34% in volume, respectively, of all gas generated from decomposing waste;
- The emissions saved when the project results in the generation of heat and/or electricity and the alternative source for this heat and/or energy implies the use of fossil fuels.

The quantification of these benefits was done based on estimation of the annual expected reduction in tones of methane and carbon dioxide (CO2) due to the project, transformation of the methane quantities into CO2-equivalent using a standard conversion factor and monetization of the resulting quantities of CO2 and CO2-equivalent using a standard value of EUR per tonne of CO2. The CO2 emission per tonne of waste included in the CBA Guides prepared by JASPERS for different countries and used in the analysis are presented in the following table:

Table 12-19: CO2 emission quantities

Type of waste	M.U.	Tons CO2
Not collected or collected and not disposed of properly	kg	1340
Mixed waste going directly to compliant landfill	kg	240
Mixed waste going directly to incineration	kg	191
Mixed being transformed into RDF and going to incineration	kg	236
Bio-waste collected separately and composted -aerobic	kg	26
Bio-waste collected separately and composted -anerobic	kg	8
Packaging waste collected separately and recycled	kg	-1618
Mixed waste to MBT for compost, with landfilling of rejects	kg	161
Mixed waste to MBT for compost, with incineration of rejects	kg	272

Source: GIZ/MSPL

12.8.4 Results of Economic Analysis

The assessment of the economic viability of the project is based on the assumptions outlined above and the anticipated project benefits as outlined in the previous section. The net present value of the main economic costs and benefits are presented in the following table.

Table 12-20: Economic benefits and costs

Economic benefits and costs		NPV@5.0%	
Project cost			
Resulting overall economic capital costs	Euro	(17,103,898)	50.77%
Incremental economic operation cost	Euro	(16,586,533)	49.23%
Overall economic project cost	**Euro**	**(33,690,431)**	100.00%
Project Benefits			
Recovery of materials and energy	Euro	7,360,899	21.67%
Extension of economic life of landfills	Euro	-	0.00%
Avoidance or proper collection and treatment of waste leachate	Euro	3,249,381	9.57%
Total benefits from avoided C02 emissions	Euro	23,355,236	68.76%
Overall economic project benefits	**Euro**	**33,965,516**	**100.00%**

Source: GIZ/MSPL

The main economic analysis indicators are presented in the following table:

Table 12-21: Economic Analysis Indicators

Economic Analysis Indicators		
Economic Net Present Value (ENPV)	EURO	275,085
Economic Rate of Return (ERR)	%	5.21%
Benefit-Cost Ratio		1.01

Source: GIZ/MSPL

The project shows satisfactory economic indicators with economic benefits significantly exceeding economic cost proving that the Project is worth co-financing.

13 Risk analysis

Risk identification present a major importance for ensure the safety in the future implementation process, allowing the identification of factors that could jeopardize the performance and sustainability of the project and establish clear conditions for their management.

In the risk analysis process was developed a Matrix in which were compiled the risks that could affect the implementation and smooth running of the project. The matrix presents the overview of project risks, with their description: causes, consequences, duration, effect on cash flow, probability of occurrence, mitigation, severity of impact, level of risk, proposed measures of prevention / attenuation.

The probability of occurrence of the identified risks was assessed according to the classification proposed in the "Guide to Cost-Benefit Analysis of Investment Projects. Economic Appraisal Tool for Cohesion Policy 2014-2020", as follows:

A: Very unlikely (0–10% probability);
B: Unlikely (10–33% probability);
C: About as likely as not (33–66% probability);
D: Likely (66–90% probability);
E: Very likely (90–100% probability).

The severity of the impact has also been assessed in line with the recommendations proposed in "Guide to Cost-Benefit Analysis of Investment Projects. Economic Appraisal Tool for Cohesion Policy 2014-2020":

I - No relevant effect on social welfare, even without remedial actions

II - Minor loss of the social welfare generated by the project, minimally affecting the project long run effects. However, remedial or corrective actions are needed.

III - Moderate: social welfare loss generated by the project, mostly financial damage, even in the medium-long run. Remedial actions may correct the problem

IV - Critical: High social welfare loss generated by the project; the occurrence of the risk causes a loss of the primary function(s) of the project. Remedial actions, even large in scope, are not enough to avoid serious damage.

V - Catastrophic: Project failure that may result in serious or even total loss of the project functions. Main project effects in the medium-long term do not materialize.

Based on the level at which the likelihood of occurrence and the severity of the impact of the risk was assessed, the level of risk was assessed according to the matrix below:

Severity/ Probability	**I**	**II**	**III**	**IV**	**V**
A	Low	Low	Low	Low	Moderate
B	Low	Low	Moderate	Moderate	High
C	Low	Moderate	Moderate	High	High
D	Low	Moderate	High	Very High	Very High
E	Moderate	High	Very High	Very High	Very High

Table 13-1: Risk Matrix

Potential adverse events	Causes	Effects	Timing	Effect on Cash Flow	Probability of occurrence (P)	Severity of impact (S)	Risk level (=P*S)	Prevention and/or Mitigation measures	Residual risk after prevention/mitigation measures
Implementation risks									
Opposition from locals referent to transfer stations and regional landfills location	The negative impact on the environment and on the quality of life of the inhabitants of the region	Delay in commencement of activity	Short	Delay in absorption with potential problems in losing part of the financing due to decomitment.	C	III	Moderate	Awareness sessions on applied technologies	Low
Delays in preparation of tender documents	Low capacity of the technical assistance consultant	Delay in commencement of works	Short	Delay in absorption with potential problems in losing part of the financing due to decomitment. Commitment.	A	II	Low	A technical assistance consultant for preparing the tender documents will be selected in order to perform the tender documents rapidly allowing the launch of the tender immediately after the financing approval.	Low
Delays in the tendering process	Appeals by the not selected companies	Delay in commencement of works	Short	No direct impact on the cash flow of the company. Delay in absorption with potential problems in losing part of the financing due to decomitment.	D	III	High	Appropriate time contingencies have been factored in into the tendering procedure. Support during the tendering process is to be provided by the Technical Assistance consultant.	Medium
No bids are received	The construction companies from the market does not have enough working capacity	Delay in commencement of works	Short	No direct impact on the cash flow of the company. Delay in absorption with potential problems in losing part	B	II	Low	Cost estimates for individual project components have been established with consideration of the current market situation. Adequate communication and	Low

Potential adverse events	Causes	Effects	Timing	Effect on Cash Flow	Probability of occurrence (P)	Severity of impact (S)	Risk level (=P*S)	Prevention and/or Mitigation measures	Residual risk after prevention/mitigation measures
				of the financing due to decomitment.				tendering process to attract possible bidders Procurement strategy designed to make the contract attractive	
Delayed obtainment of permits	Low political commitment; Mismanagement of the licensing procedure process	Delay in commencement of works	Short	Delay in establishing a positive cash flow including benefits materialization	A	II	Low	Close monitoring	Low
Construction delay	Low contractor capacity	Delays in Compliance to EU directives and national legislation	Medium	Delay in establishing a positive cash flow including benefits materialization	C	III	Moderate	Appoint project managers for each works contract inside the PIU to closely monitor the activity of the constructors in order to prevent delays.	Medium
Project cost overrun	Inadequate design cost estimates.	Investment costs higher than expected.	Short	Higher (social) costs in the first phase of the project	D	IV	High	The design of the project must be revised. The project costs were estimated based on current market conditions.	Low
Issues in corroborating of activity of transfer stations and regional landfill	Lack of predefined rules of collaboration and interaction	Difficulties in complying of the waste transfer procedure (itinerary, graph, selective collection)	Medium	Lower funds available for assuring a sustainable operation (no economies of scale).	B	II	Low	Ensuring a common base of facilities for waste recovery and disposal operations available for all actors of the waste management chain Elaboration and approval at the LPAs level of a Regional Regulation for Waste Management	Low
Difficulties in organizing operational activity	Lack of experience at national and regional level Lack of appropriately trained staff	Delay in commencement operational activity Low collection level	Medium	Lower revenues decreasing the capacity to cover operating costs, repay debt service and make investments in	D	III	High	Training sessions, Exchange of experience, study visits to local and international operators Division of responsibilities between actors of the waste	Medium

Potential adverse events	Causes	Effects	Timing	Effect on Cash Flow	Probability of occurrence (P)	Severity of impact (S)	Risk level (=P*S)	Prevention and/or Mitigation measures	Residual risk after prevention/mitigation measures
				infrastructure.				management chain	
Financial risk									
Lower tariff levels	Low political commitment toward implementation of the tariff strategy.	Lower revenues leading to sustainability problems.	Medium	Lower revenues decreasing the capacity to cover operating costs, repay debt service and make investments in infrastructure.	D	IV	Very High	The tariff strategy will be communicated and discussed with the political decision makers in the approval phase of the project. The tariff strategy should be included as covenant in the Financing Contracts.	Medium
Decommitment of funds for investments	Delays in implementation	Lower financial resources for Investment financing	Low	Significant impact because investment will have to be financed by the operator or by the Local Authorities.	A	III	Low	Appoint project managers for each works contract inside the PIU to closely monitor the activity of the constructors in order to prevent delays.	Low
Lower number of contracts with customers than expected	Lower connection of customers	Lower revenues leading to possible sustainability problems.	Long	Lower revenues decreasing the capacity to cover operating costs, repay debt service and make investments in infrastructure.	D	III	High	Awareness campaigns to convince customers to sign contracts with waste management operator. Support from local authority to increase connection level. Additional tariff increases to cover the revenues gap.	Medium
Low level of collection	Lower collection of revenues from customers	Lower revenues leading to possible sustainability problems.	Long	Lower revenues decreasing the capacity to cover operating costs, repay debt service and make investments in infrastructure.	D	III	High	Awareness campaigns to convince customers to pay the invoice on time. Support from local authority to increase collection level and impose penalties for belated payment. Additional tariff increases to	Low

Potential adverse events	Causes	Effects	Timing	Effect on Cash Flow	Probability of occurrence (P)	Severity of impact (S)	Risk level (=P*S)	Prevention and/or Mitigation measures	Residual risk after prevention/mitigation measures
								cover the revenues gap.	
Low level of recyclables collection	Lower collection of revenues from recyclables sale	Lower revenues leading to possible sustainability problems.	Long	Lower revenues decreasing the capacity to cover operating costs, repay debt service and make investments in infrastructure.	C	II	Moderate	Awareness campaigns to convince customers to sort waste. Support from local authority to increase selective collection. Additional tariff increases to cover the revenues gap.	Low
Lack of market opportunities for collected recyclables	Lower collection of revenues from recyclables sale	Lower revenues leading to possible sustainability problems.	Long	Lower revenues decreasing the capacity to cover operating costs, repay debt service and make investments in infrastructure.	D	II	Moderate	Market scanning and networking in order to identify possible opportunities within the country and abroad. Additional tariff increases to cover the revenues gap.	Low
Deterioration of assets	Advanced deterioration of existing assets as well as poor state of the existing infrastructure	Higher operating costs or possible reinvestments needed leading to possible sustainability issues	Long	Higher costs decreasing the capacity to cover operating costs, repay debt service and make investments in infrastructure.	D	III	High	Support from local authority to improve infrastructure (roads) condition. Identify alternative sources to replace obsolete assets. Additional tariff increases to cover the costs gap.	Moderate
Political and social risk									
Opposition of local political decision makers to the regionalization process	Low political commitment for allowing to “loose” the control over the local existing operators	Delays in investment implementation Delays in regional operation and implementation of economies of scale	Medium	Lower funds available for assuring a sustainable operation (no economies of scale).	D	III	High	Extensive discussion with the local authorities to explain the advantages of the project and of the operation at regional level	Moderate

Potential adverse events	Causes	Effects	Timing	Effect on Cash Flow	Probability of occurrence (P)	Severity of impact (S)	Risk level (=P*S)	Prevention and/or Mitigation measures	Residual risk after prevention/mitigation measures
Public opposition	Inadequate communication strategy Political interference Underestimation of threats	Delays in implementation of investment	Medium	No direct impact on the cash flow of the company.	A	II	Low	Awareness raising activities and campaigns to raise the level of social acceptance	Low

Source: GIZ/MSPL

14 Institutional arrangements

14.1 Legal framework applicable to IWMS in the Republic of Moldova

The national legal framework on waste management can be grouped in the following categories:

- General framework - includes the laws that establish the general provisions on waste management;
- Regulatory (administration) framework – includes specific provisions for the management and organization of waste management at community level;
- Operating framework - includes laws and regulations that regulate the relations between service operator and service delegating party (LPA).

General legal framework

The Waste Management Strategy of the Republic of Moldova for 2013-2027, adopted by Government Decision No. 248 on 10 April 2013, stipulates that "...an important issue contributing to the establishment of an integrated waste management system at **regional** level is the promotion of **inter-rayonal cooperation**, aimed at establishing **regional waste management associations**, defining distinct roles within the institutional system".
At the institutional level, the Strategy also sets specific objectives for each type of waste. For household waste, item d) states the **improvement of institutional governance in household waste management by establishing associations of local public authorities at the regional level**.
According to the new Law on Waste nr. 209 of 29.07.2016 that will come into force in December 2017 provides the local public authorities and central public authorities specific duties of waste management. The provision of Article 11 stipulates that *LPA shall contribute to the establishment of an integrated waste management system at the regional level and ensure the inter-rayonal cooperation in order to establish regional waste management associations.*

The legal framework in force: Law on Environmental Protection No. 1515-XII of 16 June 1993 and Law No. 1347-XIII of 9 October 1997 on production and household waste regulate: the way of cooperation of specialized central public authorities in environmental protection, including the competence and duties of local public administration and the competence and specific duties of specialized central public authorities and local public administration in the management of production and household waste.
According to *Law No. 1347-XIII of 9 October 1997 on production and household waste*, the LPAs have a number of duties (Articles 4-7), such as: coordinate and organize, in economic and organizational terms, the waste management actions of individuals and legal entities from the subordinated territories; pass decisions on assignment of land that should be used

for waste disposal and the development (extension) of waste processing and neutralizing facilities...; organize the collection and disposal of household waste, as well as those belonging to small producers, affecting places for storage; and other.

Regulatory legal framework

Regarding the regulation (management) of services, the following were taken into consideration: Following its last amendment by Law No. 37 of 19 March 2015, the *Law No. 1402/2002 on Public Utility Services* recognizes that "*sanitation*" is a public utility service - Article 3 and that "LPA have exclusive *competence for the establishment, organization, coordination, monitoring and controlling the operation of public utility service* and *the establishment, management and operation* of public property assets that are part of the municipal infrastructure of the respective administrative-territorial units" (*Article 14*). *Law No. 435/2006 on Administrative Decentralisation* also supports the need for institutionalization of the waste management and provides in Article 5 that PUS can be conducted through cooperation and shall be set in the agreements signed between the parties, under the law, in strict compliance with budget resources and responsibilities assumed by them. This would be the first step taken to launch regional initiatives in this area (see the Waste Management Strategy), e.g. starting the development/implementation of project proposals on waste management, rather than direct provision of this service. Article 5 (3) provides that the concluded agreements shall establish clearly the funding sources, the limits of decision-making power separately for each level of public authority, and the deadlines for agreement implementation, considering that the waste management service is not performed in a specified period.

Operating legal framework

This category of regulatory acts also includes some provisions of *Law No.* 1402/2002 on public utility services that stipulates that public utility services shall be delivered/provided by specialized operators (municipal and individual enterprises, joint stock companies, partnerships, limited liability companies, companies with other legal forms of organization), which can be the following:

- Specialized departments of local public administration authorities;
- Municipal enterprises established by one or more LPAs;
- Business operators, irrespective of their legal form of organization;
- Individuals and/or their associations.

The law also sets out conditions that shall be met by operators during service provision that shall ensure the provided services, as well as obligations that operators have towards consumers.
The law specifies that the management of public utility services shall be organized and performed through:

- Direct management - LPA authorities assume all duties and responsibilities for the organization, conduct, administration and management of public utility services. Direct management is performed by specialized departments within LPA authorities or by owned municipal enterprise;

- Delegated management - through public-private partnership agreement, LPA authorities can appoint one or more operators to whom waste management was entrusted, under that agreement, to manage the delivery/provision of public utility services, as well as to administer and operate the public municipal technical infrastructure.
-

The operators shall be delegated to manage PSCC under conditions of transparency, by public tender. The only exception are the operators of public water supply and sewerage services, founded by local public or central specialized administration authorities with a majority public shareholding. In this case, the service management can be delegated directly to them (Article 21).

14.2 Existing institutional arrangements

At the present time, there are two forms of waste management in the Republic of Moldova: *direct management* - when LPA developed a specialized department (it may be the Municipal Enterprise if it operates within a PLA's department/division); and *delegated management* - by service agreement.

Experience of inter-municipal cooperation in the Republic of Moldova:

- Joint stock company responsible for the provision of collection, transport and disposal services of municipal waste in Soldanesti, Floresti and Rezina rayons;
- Waste Management Association in the South Development Region.

Joint Stock Company responsible for Provision of municipal waste collection, transport and disposal services in Soldanesti and Rezina rayons

22 LPAs and one Rayon Council (Soldanesti) joined together and created a joint stock company responsible for the provision of municipal waste collection, transport and disposal services (operation services). The service is delegated by each administration under a Service Delegation Agreement. Company's capital was supplied by contribution in kind, i.e. equipment owned by each LPA and financial contributions.

The LPAs made the following steps to establish this Joint Stock Company:

- Prepared and made official decisions in each local (rayon) council to be a founding member on the willingness and availability for inter-municipal cooperation by association in a Joint Stock Company;
- Signed a Memorandum of Association between the founding members, setting up the conditions of the new company foundation and the contributions of each LPA;
- Prepared the foundation documents - company statute;
- Signed the statute and registered it with the State Chamber of Registration.

According to its Statute, the newly-established Company performs the following activity, inter alia: the "Company shall carry out activities related to sanitation, de-pollution and other

similar activities The Company may carry out any other activity that is not prohibited by law" (Article 4 of the Company Statute).
When the Joint Stock Company is established, each LPA shall sign with the new Company an agreement of waste management delegation. The agreement will be signed for a period of 25 years. The object of this agreement consists of the following activities: "a) the collection, transport and storage of municipal waste; b) street cleaning (sweeping and washing public roads); c) maintenance, cleaning of green areas that are situated in areas with public roads; d) street cleaning during the cold season." (Article 2, Chapter 2 of the Delegation Agreement).

The Joint Stock Company was established at the recommendation of experts who supported these LPA when starting pilot activities on solid waste management. This is an innovative company for the Republic of Moldova and is in compliance with the provisions of the existing laws regarding public service delegation to an economic operator, this operator being founded by authorities that benefit from this service. This pilot project gives us an example of a potential waste management operator.

Waste Management Association in South Development Region

Regional Waste Management Strategy for South Development Region stipulates that an association of LPAs is the most relevant model of inter-municipal cooperation. Thus, in 2012 a Waste Management Association was established.

According to the statute of this association (registered with Ministry of Justice of the Republic of Moldova under No. 5932 of 4 January 2013), the cooperation between LPAs is "an union of legal entities, which is nongovernmental and apolitical, without a lucrative purpose (not-for-profit), established by administrative-territorial units, organised according to the law, as towns (municipalities), rayon councils and villages (settlements), and by associations specialized in waste management, further members of the Waste Management Association in the South Development Region, under the Civil Code of 6 June 2002 (Articles 180, 181), European Charter of Local Self-Government of 15 October 1985 ratified by Parliament Decision of 16 July 1997 (Article 10), Law No 438 of 28 December 2006 on Local Public Administration (Articles 14, 43)".
The association is a form of voluntary cooperation without any legal enforcement to participate. At present, not all LPAs from the Development Region are part of the association. About 50 LPAs are fully fledged members and other 35 submitted an application to became members. Due to lack of funds, the Association has failed to carry out more activities listed in its statute so far.
The Association also took over from member LPAs the responsibility to delegate the sanitation service and to lease the LPA's goods in public and/or private ownership that constitute the technical municipal infrastructure.
The Waste Management Association in South Development Region covers a geographical area that includes three Waste Management Zones. Thus, this association monitors and coordinates the implementation of Regional Waste Management Strategy. A regional committee of the association will coordinate each management area.
This association was also established at the recommendation of the experts involved in the development of the Regional Waste Management Strategy. Such an association is a good

example for the regulatory function. Currently, the following LPAs from the management area 3 (Cahul, Cantemir and Taraclia rayons) are members in South IDA:

- Cahul rayon – Manta;
- Cantemir rayon - Antonesti, Chioselia, Cietu, Cirpesti, Cisla, Costangalia, Porumbesti, Enichioi, Haragis, Toceni, Sadic, Tiganca, Gotesti;
- Taraclia rayon - Taraclia town, Albota, Cairaclia, Tvardita, Valea Perjei, Musaitu, Corten, Vinogradovca, Salcia and Novosiolovca.

14.3 Options regarding sanitation service delegation

Four possible options regarding the sanitation service delegation were identified during the analysis. For each role assumed by stakeholders involved in these systems, there are several options, which are presented below. These identifications are based on the criterion of service delegating party and that of potential operator.

Table 14-1: Options regarding sanitation service delegation

Option	Service delegating party	Operator
Option A	LPAs (Memorandum of Understanding)	Public operator
Option B	IDA	Public operator
Option C	IDA	Public operator and private operator
Option D	IDA	Private operators

Source: GIZ/MLPS

All options are analysed in details below.

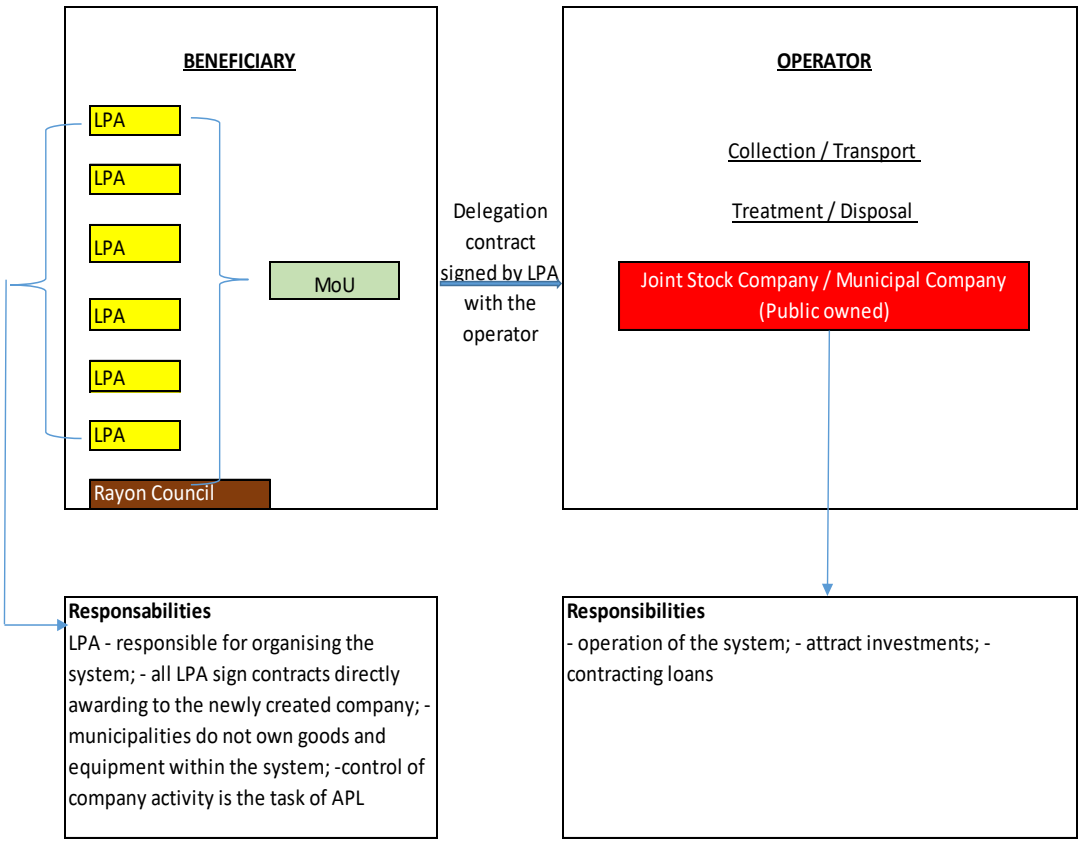
Option A

Option A is an option that is currently being tested in Soldanesti and Rezina rayons on the basis of a Joint Stock Company (JSC) that has 23 LPAs and a Rayon Council as shareholders, which delegate the collection, transport and disposal services to the Company. JSC will be established by signing a memorandum of understanding between the LPAs becoming shareholders.

This option has approximately the same elements as option B, except that in this case the LPAs do not form a waste management association. In this context, each LPA delegates the waste management service directly to the company established by all LPAs from a waste management area. The diagram below pictures the relations between the stakeholders involved in this institutional organization option.

This option is supported by the Law on public utility services, which stipulates that these services can be provided by a JSC.

Figure 14-1: Organization of regional waste management systems – Option A



Source: GIZ/MLPS

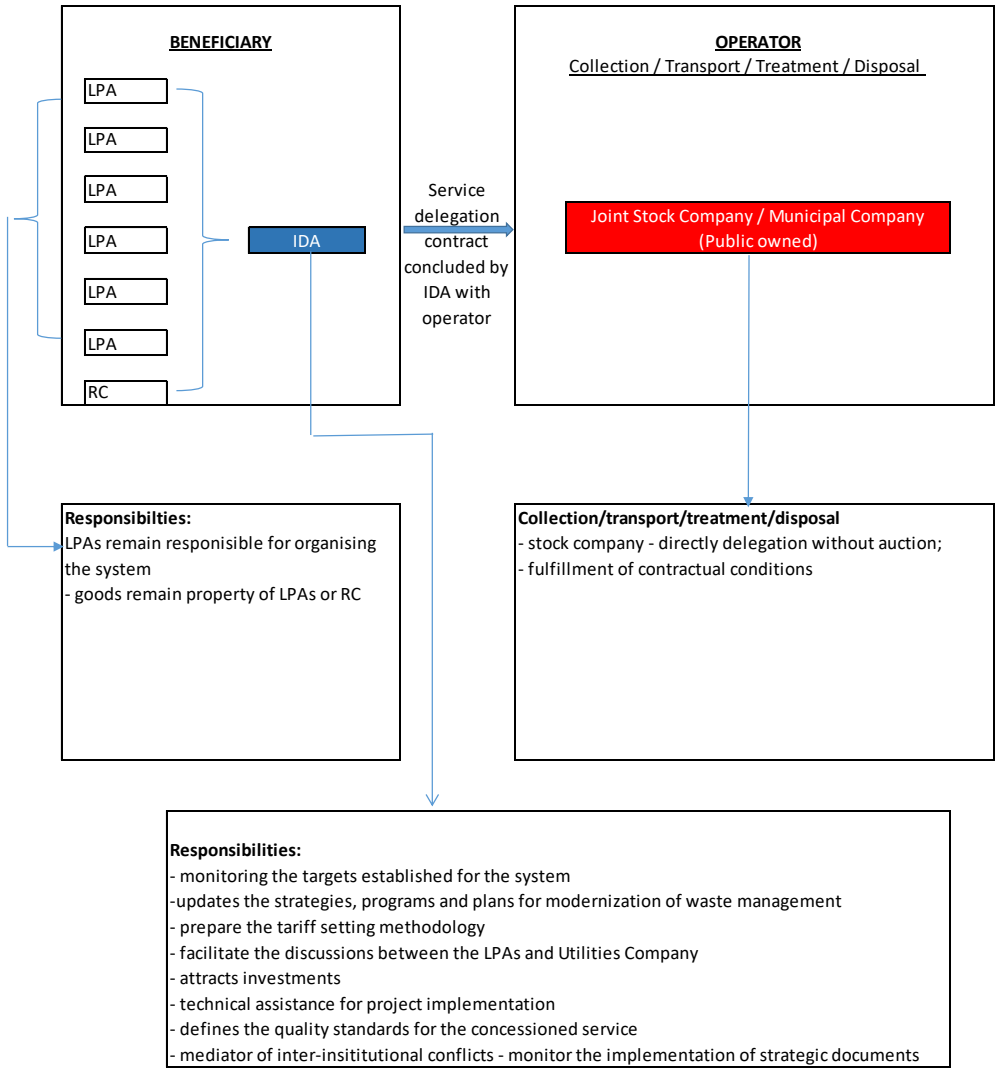
Option B

Option B is supported by national legislation, National Wastes Management Strategy and national regional development programmes and plans, policies that encourage the establishment of regional associations of LPAs to improve the institutional governance in the area of municipal waste management.

At the same time, Law No. 1402-XV of 24 October 2002 on Public Services in Community Centres provides for partnerships and inter-municipal association for systems and services establishment and operation. Priority is given to public-private partnerships, associations of local public administration authorities and private operators, regarding municipal service financing.

This option contains the following elements: a beneficiary who is represented by an Association of LPAs, a regional operator for all waste operations (collection, transport, treatment and storage). In this option, the operator is a state-owned company of public utility, established as a JSC where LPAs are shareholders, in accordance with the statute of the Intercommunity and Inter-municipal Development Association (IDA). The diagram below presents a brief description of the relations between the stakeholders involved.

Figure 14-2: Organization of regional waste management systems – Option B



Source: GIZ/MLPS

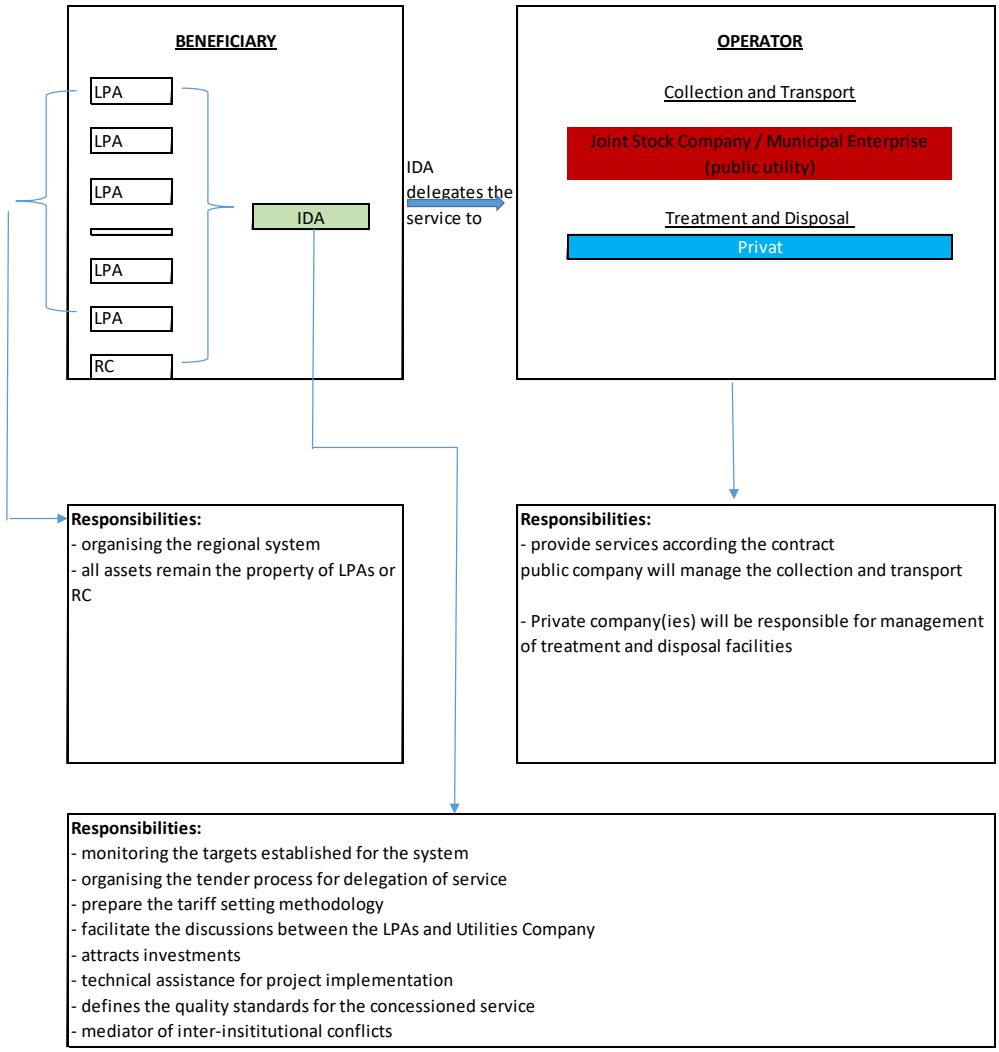
The legislation of the Republic of Moldova allows for the establishment of associations of LPAs, but it does not stipulate expressly specific types of associations, specific ways of their foundation or functioning. These associations are subject to some general provisions of the Civil Code, with regards to associations and legal entities.

Option C

Option C is a model similar to Option B at the beneficiary level, having specific traits for operators, particularly the combination of public operator and one or more private operators. The association of LPAs is the beneficiary. The division between the operation of the system and the two segments (collection and transport on the one hand, and storage on the other hand) aims at making the costs more efficient and lightening the financial burden of LPAs. According to the legislation of the Republic of Moldova, such an option is possible. There is

no legal or administrative impediment that would interfere with the implementation of this option. This option is pictured in the diagram below.

Figure 14-3: Organization of regional waste management systems – Option C

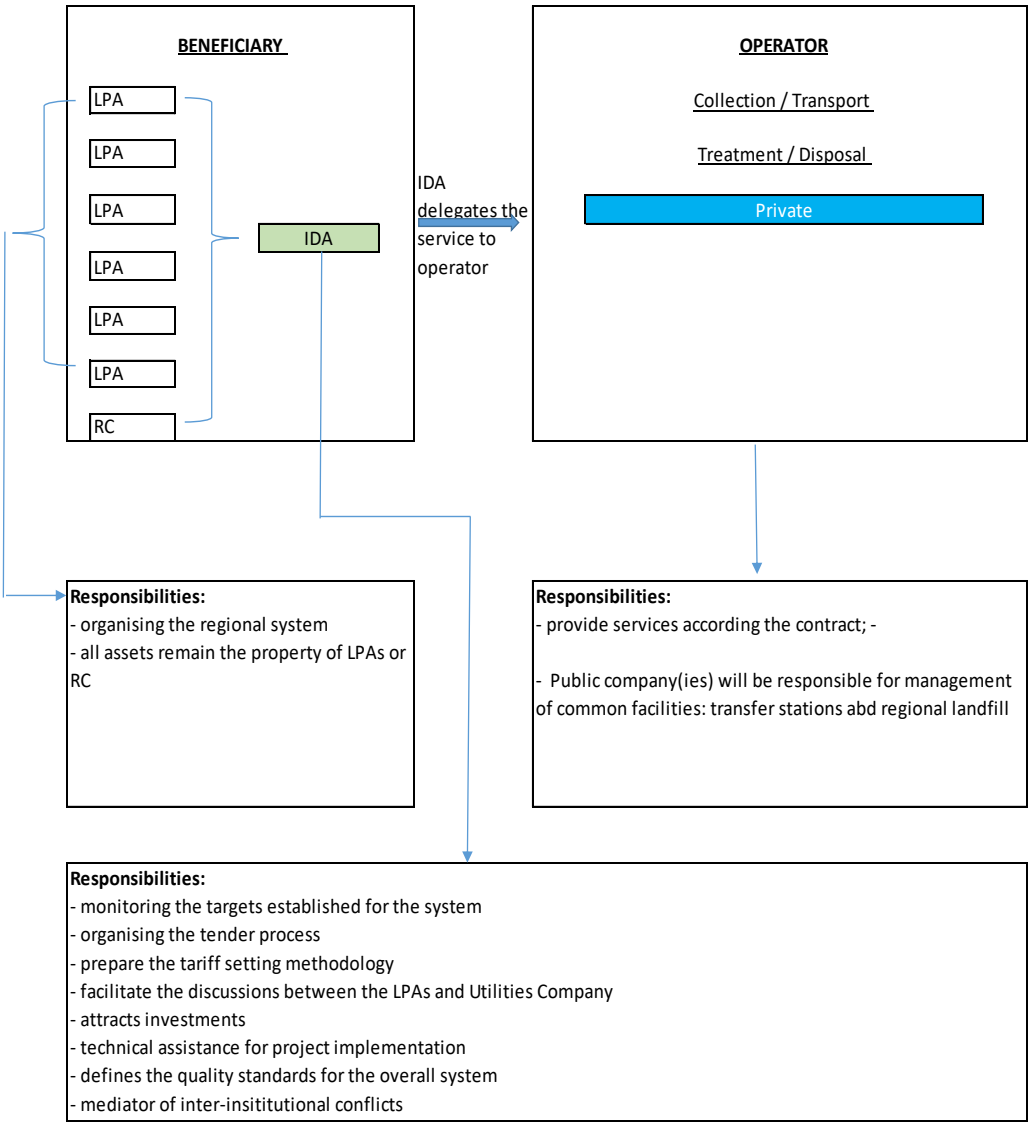


Source: GIZ/MLPS

Option D

Option D is underlain by a liberal economic model, with a waste management market open to private operators for the collection, transportation, transfer and storage of waste. This model includes, though, an association of LPAs at the beneficiary level, establishment of IDA in order to ensure representativeness and system coordination. Like the previous opinion – the existing legal framework allows for the provision of public services by business operators, regardless of their legal organization form. The diagram below pictures the relations between the stakeholders involved in this institutional organization option.

Figure 14-4: Organization of regional waste management systems – Option D



Source: GIZ/MLPS

The tables below contain the advantages and disadvantages found during the assessment of the four identified options. Both advantages and disadvantages are grouped according to the service delegating party (also referred to as IDA) and to the operator. As for Options B, C, D the service delegating party is one and the same “IDA”, therefore the advantages are also the same. The options were also assessed against the five criteria included in the assessment of the current situation in the Republic of Moldova, namely: client’s capacity, operator’s capacity, economic, political and socio-cultural conditions.

Table 14-2: Advantages of the options regarding sanitation service delegation

<table>
<tr><th>Option A
Delegating party
LPAs
Public operator</th><th>Option B
Delegating party – IDA
Public operator</th><th>Option C
Delegating party
IDA
Public and private operators</th><th>Option D
Delegating party
IDA
Private operators</th></tr>
<tr><td rowspan="2">Less time and lower cost to organize institutional cooperation;
Transfer of the existing experience into the development of the operator.</td><td colspan="3">Representation of LPAs at the system level;
Systemic approach towards the entire process;
Coordination of investments;
Organization and management of PIU;
Smaller risk of conflict between LPAs;
Fair division of costs and beneficiaries per LPAs.</td></tr>
<tr><td>Transfer of the existing experience into the development of the operator.</td><td>Transfer of the existing experience into the development of the operator;
The private operator has experience in using the equipment.</td><td>A institutional model focused on performance and economic efficiency;
Transparency in decision making;
Private operators can have experience in using IWMS.</td></tr>
</table>

Source: GIZ/MLPS

There are several advantages to *Option A*, but the main one is the following: organization of institutional cooperation between LPAs would take less time because the institutions are already parties to the Memorandum of Understanding (MoU). The parties know one another. All main aspects were discussed at the stage of negotiations, which enabled the parties to get involved quicker in decision-making, which shall reduce, thus the costs. Attention should be paid to the fact that the LPAs that are parties to the MoU have experience in waste management at the local level, and this experience can be invested in the development of the operator.

As it was previously mentioned, the other three options – B, C, D – have a common trait– the Intercommunity/Inter-rayonal Association of LPAs (IDA) and their advantages in this respect will be presented together. As IDA is an organized and registered structure, one of the main advantages is that the institution will take part in the public and civil relations as one single entity, representing the interests of the LPAs at the system level. We ought to highlight that the legal entity created by LPAs will have a systemic approach towards the entire waste management process – collection, transportation and storing of municipal waste. Besides the aforementioned, it would have knowledge of the issue, system, and infrastructure of the involved communities. Another important role of the IDA is to coordinate investments, since a great focus should be put on attracting the investments needed for the development of the system. As far as attracting and coordinating investments are concerned, IDA has the advantage that it has the possibility of, and experience in organizing and managing the Project Implementation Unit. The IDA type of organization is also advantageous as there would be smaller risks of conflicts between LPAs, because they would have had already agreed on and countersigned the main conditions on its functioning upon the submission of the decision to the Local Councils to accept the status of member of IDA. Being a structure that will have had all its operation matters negotiated, another advantage would be the preliminary approval of the scheme on the division of costs, and thus, of beneficiaries between LPAs in a pre-established and fair manner.

The analysis identified several advantages, and namely: as the use of the existing experience for the development of the operator and the equipment is an advantage for the beneficiary, because it is presumed that the beneficiary already had the experience before the establishment of IDA – this is, in essence, an advantage for the operator as well. This is explained by the fact that the operator gets some experience/knowledge of the matter and situation from a local stakeholder. The private or public operator that was selected transparently and on the basis of principles of competition will focus its entrepreneurial activity on achieving performance, providing quality services and, and on economic efficiency. There's the other side of the coin, i.e. that the market of these services is liberalized and private operators that have experience in working with IWMS can also register for the contest.

Table 14-3: Disadvantages of the options regarding sanitation service delegation

<table>
<tr><th>Option A
Delegating party
LPAs
Public operator</th><th>Option B
Delegating party – IDA
Public operator</th><th>Option C
Delegating party
IDA
Public and private operators</th><th>Option D
Delegating party
IDA
Private operators</th></tr>
<tr><td rowspan="2">Delegating party = Operator;
The system can be controlled by the strongestLPA;
There are risks that conflict might occur between LPAs;
The MoU does not provide a complete legal framework for the management of IWMS;
The LPAs will not be able to participate as shareholders if they do not have a budget/goods;
Operator's lack of experience in IWMS operation.</td><td colspan="3">There is no specific legislation on the establishment of IDAs;
Greater efforts are need to establish an IDA;
Difficulties in making decisions;
Dependence on the financial allocations from local budgets.</td></tr>
<tr><td>Operator's lack of experience in IWMS operation.</td><td>Long-time need for the delegation process.</td><td>Long-time need for the delegation process.</td></tr>
</table>

Source: GIZ/MLPS

For *Option A* there's the disadvantage of LPA's role overlapping. On the one hand it appears as the service delegating party when it countersigns the MoU, and then on the other hand it appears as Operator, because the JSC assumes the role to operate services and equipment. Since the MoU does not contain anything on the management of gains, the role of leader may be gradually taken on by the strongest LPA (from financial point of view, and/or the one that has equipment and machines). Obviously, once leaders emerge and the powers are divided, there will appear the risk of conflicts between LPAs.

The theory of law says that the Memorandum of Understanding is in its essence the act that merely regulates parties' intention to start an activity, and does not provide, thus, the complete legal framework for the management of IWMS. As for the establishment of a JSC there is the requirement that LPAs must have budgets/goods in order to be able to join as shareholders – the disadvantage is that not all LPAs will enter on equal conditions, or will not be in as shareholders of the company at all. We must take the risk that once a new company is created, it will not have much experience with IWMS.

The disadvantages of options B, C, and D were examined jointly and are the following: although the legislation of the Republic of Moldova is developed enough with regards to the

regulation of legal entities' organizational forms, the fact that there is no specific legislation for the organization of IDAs is noticeable. Another disadvantage is the big number of LPAs at rayon level that would come under a waste management region, this implying greater efforts for the creation of IDAs, which entails another disadvantage – i.e. difficulty in making decisions.
As for operators, the disadvantages would be the following: as mentioned earlier – a newly-created operator has little experience or even none at all with IWMS operation. Since many LPAs are involved in this activity, delegating takes longer and needs to be improved as experience is being gained.

Considering the aforementioned, every option comes with advantages and disadvantages. The main conclusions of the analysis are the following:

- National Wastes Management Strategy recommends to LPAs to join in order to organize regional waste management services. LPAs decide on the form of association. The level of representation and control of regional systems will determine the future associations. IDA associations are forms commonly found in Europe and beyond, ensuring a greater level of representation and control than other forms of association;
- The experience of the South in LPAs association by organizing an integrated waste management system reveals that it is possible to establish IDA association in the Republic of Moldova;
- The lack of an institution that would regulate waste management services could lead to a low performance in this area. IDAs could take over, at least temporary, the role of regulatory actor in this area, fundraising, contracting (organize, prepare tenders, participate in negotiations, discuss common approaches for the served region);
- The lack of specific legislation in the Republic of Moldova to organize intercommunity development associations prove the fact that the legal framework needs to be improved in order to achieve a better conduct of activities. The new legal framework should provide clearly the institutional system at the regional level and divide the roles and functions between stakeholders;
- Given the lack of resident private companies in waste management area (for collection, transport and storage) and the lack of work experience with investors in this field, options A, B or C are currently the most optimal for the organization of regional systems of integrated waste management in the Republic of Moldova;
- Due to lack of experience at the national level regarding the operation of waste sorting, composting stations and waste storage facilities, delegation of the operation of these facilities to a private operator will bring a technical advantage.

15 Socio-economic impact and gender aspects

The management of municipal solid waste is a challenging issue because of the associated ecological, social and economic consequences. In our case the socio-economic impact of the project is conditioned by a number of factors among which one can mention the, economical, social, rural-urban, demographical and gender aspects.
Currently, almost every locality has its own landfill. Most of these landfills are not controlled, although some of them have been monitored and transformed in controlled or partly controlled landfills. At present the coverage rate of the sanitation service in urban areas is about 68 % per WMZ 8 with variations from 52% in Briceni rayon to 76% in Edinet rayon. In rural areas, the coverage rate of the sanitation service is much lower reaching hardly the level of 2% on average per WMZ 8, of which in Ocnita rayon about 5% of rural population have access to sanitation services, while in Donduseni this level is equal to zero. Even in the villages that have a sanitation operator, only a small part of the population benefits of these services.

The approach used for setting the level of fees for waste collecting is more socially than economically oriented. That is why the volume of fees collected from population is low and often does not cover the level of costs necessary for maintenance works at authorized landfills.

An important part of the urban and especially of the rural households tries to avoid signing of contracts for waste collection with sanitation operators. This is another reason for low level of access for sanitation services in rural areas of WMZ 8. Furthermore, in urban and more evidently in rural areas one can find a plenty of alternative irregular dumpsites where the waste can be thrown by individuals with minimal costs.
Shortcomings in the present system of waste management make the waste sorting and recycling less economically attractive and hamper development of businesses in the field of the waste management.
The unpleasant odour of the uncollected garbage and out of the irregular dumpsites makes the life in such places less comfortable and attractive. A large number of insect, worms and other animal outbreaks existing in present irregular dumpsites increase the incidence of the health risks for persons living in the neighbourhood.
The open fire caused by burning waste besides of the release of smoke and poisonous gases giving rise to safety problems can serve also as source for outbreaks of vegetation fires especially in the dry seasons

Table 15-1: The present socio-economic and gender shortfalls of existing SWM system

Subject of environmental protection	Existing environmental shortfalls
Economical aspects	• Irregular dumpsites does not offer sufficient possibilities for local public authorities to collect fees from the population that could be used for improvement and sustainable development of the waste management services • A large part of the urban, and especially of the rural households, tries to avoid signing of contracts with sanitation operators • Costs for waste sorting and subsequent recycling are rather high since sorting is done directly on the landfill out of unsorted mixture of organic and inorganic waste

Subject of environmental protection	Existing environmental shortfalls
	• A limited number of businesses developed in the field of waste sorting and recycling
Social aspects	• Only about 20% of population in the WMZ 8 area have access to organized waste management services • The existing level of fees for waste collecting charged from the population is rather affordable even for socially vulnerable persons and households • The unpleasant odour of the uncollected garbage and out of the irregular dumpsites located reduce the attractiveness of the housing market in surroundings • A large number of insect, worms and other animal outbreaks existing in present irregular dumpsites creates serious problems for the health of persons living around • The open fire caused by burning waste besides of the release of smoke and poisonous gases giving rise to safety problems can serve also as source for outbreaks of vegetation fires especially in the dry seasons
Rural urban aspect	• There is big gap between the level of access to sanitation services in rural and urban areas • A lower enforcement of the legal stipulations for the irregular disposing of waste in villages comparing to urban areas
Demographic aspects	• Poor social infrastructure in the rural area of WMZ 8 acts as an additional motivating factor for migration of the rural population in urban areas or abroad • Lack of access to organized waste management services contributes to the increase of morbidity among rural population.
Gender aspects	• The women bear the burden of the large part of the farming activities and home works

Source: GIZ/MLPS

A well working waste management system will have a positive impact over business and investment climate in the WMZ 8 rayons since this will influence positively first of all the economic development of this area.

The Integrated Waste Management system will have as one of direct outcomes creation of new working places that will have a positive impact on the economic development and increasing the living standard of the population in all WMZ 8 rayons.

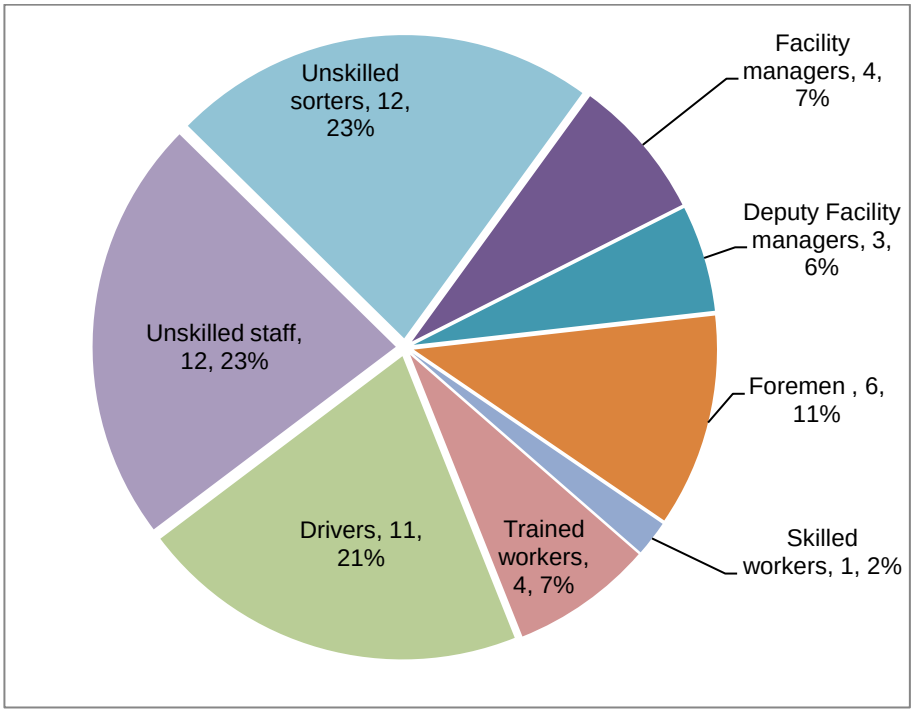
Per total in all units of the WMZ 8 will be employed 53 persons, of which about half (46%) will be unskilled labourers, both men and women. About 30% of newly created working places will involve skilled labour force, including drivers and other trained workers.

This will allow employing skilled and unskilled persons from neighbourhood villages that often meet problems in finding a proper working place in their villages.

Implementation of the IWMS in WMZ 8 will be inherently linked with development of new economic activities related to collecting, sorting, transporting and recycling of the household wastes.

Particular attention will be paid to promoting of composting the organic waste that will contribute to the amount of organic fertilizers introduced in the agricultural circuit and will influence positively the efficiency of the agricultural production. From other side this will reduce significantly the volumes of waste collected and the economic efficiency of the waste management system.

Figure 15-1: Structure of the staff planned to be employed in the WMZ 8 facilities



Source: GIZ/MLPS

Potentially in the place of the authorized landfills could be developed activities for capture of the methane gas that can contribute to the green energy production and to energy security of villages located in the vicinity.

As an indirect economic impact the implementation of the Integrated Waste Management System in WMZ 8 will contribute to the development of the transport, technical and other services.

One of the important economic effects created by implementation of the Integrated Waste Management System is the impact on residential property values. Residential property values are affected by a number of factors like good road network, infrastructure facilities (water, electricity, drainage, etc) accessibility and demand, location and distance. Apart from this, residential property values are affected by the generation and management of the solid waste.

The social impacts created by implementation of the Integrated Waste Management System will include the reduction of the unpleasant odour of the uncollected garbage and out of the irregular dumpsites. Another positive social impact will be the reduction of insect, worms and other animal outbreaks existing in present irregular dumpsites.

Table 15-2: The expected socio-economic and gender impact of the IWMS

Subject of environmental protection	Expected environmental advantages/impacts
Economical	• On the long term, after 2023 – about 35 % of the packaging waste generated in rural areas and 45 % of the packaging waste generated in urban areas will be recycled, while organic

Subject of environmental protection	Expected environmental advantages/impacts
aspect	waste will be recovered at the rate of 100 %; • 70 % of the generated bulky waste will be properly treated for recycling and/or disposal in safety conditions; • About 70 % of the construction and demolition waste will be properly treated for recycling and/or disposal in safety conditions; • New working places will be created after the implementation of the IWM system • The Local Public Administration will have an additional income source from fees charged for waste collecting • Promoting of composting and home composting of the organic waste will contribute to the amount of organic fertilizers introduced in the agricultural circuit that will influence positively the efficiency of the agricultural production • Reduction of the number of irregular dumpsites will allow utilization of the lands used before as a landfill in economic, social and environmental activities • Improved living conditions will cause the increase of the residential property values in rural and urban areas • Improving external exchange reserves by exporting recycling materials; • Fostering agricultural productivity by producing compost according to the criteria quality; • Local energy security by recovering energy from waste
Social aspect	• The access of population in the WMZ 8 rayons to organized waste management services will increase to 100% by 2020 • The low income households will have difficulties in paying the required waste management taxes/fees that could increase the inequalities in living standards • Significant minimization of the water, soil and air pollution generated by uncollected waste or by irregular dumpsites will improve the living standards of the neighbourhood population • Enhancement of hygienic situation in living areas, because the amount of scattered waste will be reduced significantly due to the improved waste collection services. • A number of persons from WMZ 8 villages will be employed at collecting and sorting units that will improve their living conditions
Rural urban aspect	• Better access of the urban and especially rural population to sanitation services • Reduction of the migration flow of the rural population to urban areas
Demographic aspects	• Improving the living standards can contribute to the reduction of the morbidity in rural areas creation • Better living standards will contribute to the stabilization and gradually increase of the rural population in the WMZ 8 rayons
Gender aspects	• A certain number of women will be employed in WMZ % collecting and sorting units that will assure a more equal distribution of the newly created working places in the IWM system according to the gender criteria • Better aces of women in rural area to improved sanitation services will reduce their burden of the homework

Source: GIZ/MLPS

Elimination of the open used for burning the waste will reduce the release of smoke and poisonous gases. Reduction of the unauthorized landfills will contribute also to the return of some plots of land in agricultural use under the form of pastures, forest land or agricultural land or just in the form of green areas.

Additional indirect positive effects are expected from the economic development. The improvement of living conditions for the poor farmers will positively influence particularly the women, because they are the backbone of family workforce in farming and homework.

The major part of the unauthorized dumpsites is located in the rural area in the closest neighbourhood of villages. Therefore implementation of the IWMS will have a strong positive impact in rural area. Moreover improving living standards in rural area could reduce the migration flow from villages.

Currently, the living standards of the urban population differs from that in the rural area, which has less economic outlook, lower per capita income compared to the urban population and difficult access to public sanitation services.

Improving the living standards in the WMZ 8 rayons could influence the stabilization of the population in these rayons and development of the socio-demographic indicators.

Developing towns as urban centers presents an opportunity for development the regional policy, including for the implementation of public service policy, being viewed as a perspective for the gradual revitalization of the economy of the Republic of Moldova

One should keep in mind that newly created working places will be oriented largely toward less qualified labour force and could involve persons from the socially vulnerable population, both men and women.

The indirect effects of the IWM system may improve the living conditions of population, particularly of women. The improved hygiene due to clean up of waste accumulations and closure of dumpsites can reduce diseases and injuries of children, what takes away a burden from the mothers.

Taking into consideration that women and children are usually more involved in household activities, including the activities related to waste disposal, the increase of access of population to organized waste management services will mostly benefit these groups of citizens.

Creation of improved conditions for collecting of the household waste could reduce significantly from the burden of the daily work, performed as a rule, by women. Better organized and cleaner waste collecting points could motivate also the men population to give a helping hand to women from their families.

Another important aspect lies in educating the younger generations that is, as a rule, one of the basic educational functions attributed to women. Thus are created conditions for promotion of some norms and behavioral standards concerning the modes of separate waste collection, storage and recycling the household waste

From social point of view the access to waste management services is not equal for every household in the project area. The low income households (which usually include the families with many children, families with only one parent, families with retirees and disabled persons) will have difficulties in paying the required waste management taxes/fees. In this situation the local government should take actions in order to foster the livelihood of the poorest. Subventions could be given to poor families in order to cover the public services provided in the municipalities, including waste management services

Providing appropriate landfill volume will allow the authorities to impose the laws and regulations regarding waste disposal more strictly towards the citizens and the commercial waste generators. Problems like littering and irregular disposal outside of designated areas will become easier to prosecute, since nobody can claim a lack of disposal options.

16 Environmental impact

Currently, almost every locality has its own landfill. Most of these landfills are not controlled, although some of them have been recently monitored and transformed in controlled or partly controlled landfills. Most landfills are not guarded or fenced. Most dumpsites are located with violations of regulations in force and no security service is available. The location of the landfills varies: silage pits or liquid manure pits of the former animal farms, on clay quarries, on slopes affected by landslides, at the road margins, on ramps, hill ridges, etc.

At present only about 68 % of the urban population in WMZ 8 have access to sanitation services. In rural areas, the coverage rate of the sanitation service is much lower (about 2%). Even in the localities where there is a sanitation operator only a portion of the population benefits of these services.

The organic and agricultural waste is not collected separately that creates a range of problems for its sorting and recycling.
A large part of the household waste from rural areas is thrown uncontrolled all around neighbouring areas, including streets, areas at the edge of the village, common lands like pastures, valleys of rivers, rivulets, ravines, or in forest zones. The indiscriminate waste is being either dumped at irregular dumpsites, buried in the backyards, or burned that have a negative impact over human beings, soil, water, climate, air and landscape.
The negative impact of the existing system of waste collection over the population is created first of all by the poor hygienic situation in living areas, but also on dumpsites and in the neighboring areas. The inadequate waste management in the existing dumpsites creates conditions for environment pollution in adjacent areas. Thus the waste (and especially plastic bags) is blown from the dumpsites by the wind to the neighboring yards and agricultural land fields. This has also a negative impact over the landscape that looks unattractively when is littered with paper, plastic bags and other things carried by the wind.
Another problem is related to the rain water that falling over the irregular dumpsites infiltrates the soil, streets and gardens of neighbouring living areas. In rural area shallow wells are an important source of drinking water for villagers. At the same time the water from the major part of the shallow wells is polluted by leachate that originate from irregular dumpsites located sometime at a very close distance from shallow wells.
The large number of irregular dumpsites and their proximity to living areas creates favourable conditions for spread of diseases by rodents, insects and birds.
In certain seasons like spring and in fall the air pollution (especially in rural areas) is increasing due to burning of organic waste. Often the waste on uncontrolled dumpsites is burned by itself or by human beings that creates an unpleasantly smelling smoke.

Table 16-1: The impact of existing SWM system

Subject of environmental protection	Existing environmental shortfalls
Human beings	• Scattered waste negatively affects the hygienic situation in living areas • Due to missing waste facility management the dumpsite operations are inadequate and there is the potential for pollution over adjacent areas • Waste blown from the dumpsites by the wind to the neighbouring yards and agricultural land fields; • Water from the dumpsites infiltrating the soil, streets and gardens of neighbouring living

Subject of environmental protection	Existing environmental shortfalls
	areas; • Unhygienic conditions on dumpsites are a threat to all persons entering the area • Rodents and insects can spread diseases
Soil	• Indiscriminate disposal pollutes soil
Water	• Indiscriminate disposal pollutes groundwater • Disposal of waste without any protective measures pollutes soil and groundwater • Leachate generation from dumpsites may pollute the groundwater • No storm water management and potential for runoff of leachate into storm water drains
Climate and air	• Bad smell from the landfills in neighbuoring living areas • Smoke from burning waste • Uncaptured methane gas emission from the dumpsites.
Landscape	• Due to missing waste facility management the disposed waste pollutes large areas • Waste from the landfills blown by the wind to neighbouring yards; • High consumption of dumpsite space due to unorganized operation

Source: GIZ/MLPS

With the planned IWMS in WMZ 8 the major gaps of the existing system will be closed, at least partly.

The impact of the implementation of the IWMZ over the environment in WMZ 8 will be multiple and positive. The centralized and organized collection of the household waste will contribute first of all to the reduction of the number of irregular dumpsites in the WMZ 8 rayons and subsequently to the reduction of level of environment pollution in these rayons. With the introduction of waste collection in the rural areas the negative effects from littered waste (hygiene, soil and water pollution) will be reduced.

Collecting of the organic waste will have a big impact on the health of the population since one of the major sources for water pollution in the shallow wells and other water sources is the contamination with leachate originating from unauthorized dumpsites.

Table 16-2: The expected environmental impact of the IWMS

Subject of environmental protection	Expected environmental advantages/impacts
Human being	• Better access of the urban and especially rural population to sanitation services • Enhancement of hygienic situation in living areas, because the amount of scattered waste will be reduced significantly due to extended collection services.
Soil	• Significant reduction of the soil pollution
Water	• Significant minimization of leachate generation, that may pollute surface and/or groundwater; • Significant minimization of odour generated from deposited waste.
Climate and air	• Significant minimization of methane gas and CO^2 emission potential of deposited waste; • Substitution of primary resources by secondary raw materials.
Landscape	• Minimization of required landfill volume and closure of dumpsites.

Source: GIZ/MLPS

The collected waste will be disposed at improved dumpsites where they will be sorted for recycling. This refers first of all to the non-biodegradable wastes such as plastic, glass, metals, etc. This will improve considerably the landscape surrounding existing dumpsites.
Another problem solved by IWM system is related to the release of methane gas and carbon dioxide by decomposing garbage. Due to the small amount and the comparably large area of the dumpsites, the growth of the waste piles is slow which allows the waste to aerobically decompose. Thus, the generation of methane and organic leachate will be comparably smaller.

The restricted access to the authorized dumpsites will reduce the danger of injuries and health risks for unauthorized persons on the dumpsites.

Implementation of the IWMS will reduce significantly creation of new pollution outbreaks, including leaks of the residual waters, pollution of the ground waters, air and soil pollution etc. through a direct impact over reduction of the unauthorized landfills. In consequence, the environmental impacts of the new IWMS will be significant lower than the current impact.

The Environmental Impact Assessment procedure for the project "Integrated Waste Management System in Waste Management Zone 8, North Development Region" will be carried out according to the national and EU legal provisions.

17 Procurement strategy and implementation plan

17.1 Financing options

The procurement strategy takes into account that the following options for financing of the investment are available:

- **Grant funds**. Grant financing could be available either through the state budget or through external sources, like the EU or foreign donor organisations;
- **Investment loan**. Financing of all investments through loan obtained from International Financing Institutions (IFI);
- **Combination of grant funds and investment loan**. International practices show that a possible way of financing of such investments is a combination of grant funding of certain part of the investment with loan financing from IFI for the rest part of the investment.

Regardless of the type of financing, the project should be implemented in accordance with the existing procurement procedures. Furthermore, regardless of the type of financing, there will be a need for project implementation support. This implementation support is needed with regard to procurement, preparation and evaluation of tenders, contract award and administration, financial control, project management and reporting of project expenditures.

17.2 Public procurement process

The standard public procurement process involves the following steps:

- Notification of opportunities for tendering;
- Prequalification where appropriate;
- Invitation to tender and issuance of tender documents;
- Receipt of tenders, evaluation of tenders and contract award; and
- Administration of contract.

General Procurement Notice is issued that informs the business community about the nature of the project. This notice includes the amount and purpose of the loan and/or investment grant and the overall procurement plan, including:

- The goods, works and services to be procured;
- The expected timing; and
- Name and address to contact to express interest and obtain additional information.

This notice is published on the Client's own procurement web site and on official government procurement portal. In addition, the notice shall be submitted to the International Financing Institution(s) (IFI), which will arrange for publication of the notice. The notice shall be published not later than 45 days before invitations to tender are issued in the procurement section of the IFI.

Prequalification of Tenderers may be applied. The prequalification criteria include: experience and past performance on similar contracts; capabilities with respect to personnel, equipment, and construction or manufacturing facilities; financial position.

17.3 Main procurement procedures

The main principle governing the award of contracts is to achieve competitive tendering. The purpose of competitive tendering is twofold:

- To ensure the transparency of selection of contract awardee; and
- To ensure the desired quality of services, supplies and works at the best possible price.

The available procurement procedures are:

- **Open tender** - takes place in a single stage and any interested party may submit a bid;
- **Restricted tender** - consists of two stages, and only the bidders selected by the contracting authority at the first stage will be invited to submit bids at the second stage;
- **Competitive dialogue** - any interested party may submit a bid. The contracting authority may have a competitive dialogue only with the accepted candidates. Only the candidates selected by the contracting authority are invited to submit a final offer;
- **Negotiation** – the contracting authority discusses and negotiates the contractual clauses, including the price, with the selected candidates from amongst suppliers, contractors and providers. The contracting authority may, or may not publish a notice for invitation to negotiations;
- **Request for offers** – a simplified procedure according to which the contracting authority requests offers from several suppliers, contractors, and providers.

Open tendering provides the greatest opportunity for competition and satisfies the needs for economy and efficiency, giving adequate notification of contract requirements to all tenderers. Therefore, it is recommended that the procurement process for WMZ 8 is based on open tendering.

17.4 Procurement strategy

The present Feasibility Study has identified that the following investments are needed for establishment of integrated solid waste management system in WMZ 8:

- Supply of equipment for waste collection and transport, including equipment for separate collection of recyclables;
- Construction of two transfer stations in Briceni and Edinet;
- Construction of a sorting station in Edinet;
- Construction of a composting plant in Donduseni;
- Construction of new sanitary landfill in Donduseni.

The project costs for the initial phase are presented in section 11.

With regard to implementation of the investments needed for WMZ 8, the table below presents the type of contracts envisaged.

Table 17-1: Type of contracts envisaged

Investment cost item	Location	Type of contract
Landfill construction, including equipmment	Donduseni	WORKS 1
Composting plant construction, including equipment	Donduseni	WORKS 1
Transfer stations construction, including equipment	Briceni, Edinet	WORKS 2
Sorting station construction, including equipment	Edinet	WORKS 2
Residual waste collection equipment	All 4 rayons	SUPPLY 1
Separate waste collection equipment	All 4 rayons	SUPPLY 1
Construction Supervision	Donduseni, Edinet, Briceni	SERVICE 1
Technical Assistance	All 4 rayons	SERVICE 2
Public Awareness	All 4 rayons	SERVICE 3

Source: GIZ/MLPS

The sections below present the different type of contracts which will be needed for implementation of the project.

Works contracts

The Works Contract will be tendered as Open Tender according to the Moldovan Public Procurement Law. The Open Tendering shall take place in a single round and any interested party may submit a bid. The time period between the date of the procurement notice being sent to the Official Journal of the European Union and in the ESPP (Electronic System Public Procurement) for publication and the deadline for submitting offers shall be at least 52 days (calendar days).
For construction works two main type of FIDIC contracts are internally used – Red Book and Yellow Book:

- **The Red Book** – "Conditions of contract for construction for building and engineering works designed by the employer".

  The Red Book is the FIDIC recommended form of contract for building or engineering works where the employer has been responsible for almost all of the design. According to this type of contract, payment is made according to bills of quantities. In certain cases payment can also be made on the basis of agreed lump sums for scope/items of work. The Red Book is administered by a third party - an engineer. The engineer is responsible for monitoring the construction work on behalf of the employer. The engineer also certifies the outputs achieved and the payments to be made to the contractor;

- **The Yellow Book** – "Conditions of contract for plant and design-build for electrical and mechanical plant and for building and engineering works, designed by the contractor". This type of contract is used on projects where the contractor carries out the detailed design of the project based on performance specification prepared by the employer. The Yellow Book is therefore used predominantly for the provision of plant and for building or engineering works on a design/build basis. The Yellow Book is a lump sum contract whereby payments are made according to achieved initially specified outputs. Like the Red Book, these outputs are certified by an engineer. The contractor is also subject to a "fitness-for-purpose" obligation in respect of the completed project.

The FIDIC Yellow Book is particularly useful for construction of installations, where the contractor will be responsible for the design of the buildings and structures which will accommodate the envisaged equipment/installation, and specifically the electrical part. Besides, as mentioned above, all risks will be borne by the contractor (since he will build based on his own design) and not by the employer (due to faults/unfitness in the design).

The tables below present the works contracts envisaged.

Table 17-2: Construction of landfill and composting plant in Donduseni

Item	Details
Contract subject	Construction of landfill, composting plant and temporary storage area, supply of equipment
Contract budget without contingencies	EUR 4,621,600
Type of contract procedure	International Open Tender – FIDIC Red Book for landfill, FIDIC Yellow Book for composting plant

Source: GIZ/MLPS

Table 17-3: Construction of Briceni and Edinet transfer stations and Edinet sorting plant

Item	Details
Contract subject	Construction of transfer stations and sorting station, supply of equipment
Contract budget without contingencies	EUR 2,231,200
Type of contract procedure	International Open Tender – FIDIC Yellow Book

Source: GIZ/MLPS

Supply contract

The tables below present the supply contract envisaged.

Table 17-4: Supply of waste collection and transport equipment

Item	Details
Contract subject	Supply of: • Containers for residual waste collection – 1.1 m^3 metal, wheeled, with lid • Bins for residual waste collection – 120 l plastic, wheeled, with lid • Containers for separate collection of recyclable waste – 1.1 m^3 plastic, wheeled, with lid • Containers for construction and demolition waste – 4 m^3 metal • Trucks 16 m^3 • Trucks 10 m^3 • Vehicles for supervisors
Contract budget	EUR 3,523,200
Type of contract procedure	International Open Tender

Source: GIZ/MLPS

Services contracts

In order to implement a project of such magnitude, Consultant will be needed to provide technical assistance to the Beneficiary communities for management of the project.
The responsibilities of the Consultant will consist of at least the following:

- Coordination of project activities among the different partners (PIU of the Beneficiary, contractors, executive agencies, etc.);
- Support the Beneficiary in the preparation of Terms of References and tender dossier for procurement of contracts;
- Monitoring of the project performance of contractors in respect of approved components in the work plan;
- Planning of cash flow requirements and setting of priorities for the implementation of activities in close cooperation with the Beneficiary;
- Preparation of regular reports on the status of projects activities as agreed in the Work Plan;
- Representation of the Beneficiary in Steering Committee and Technical Committee Meetings.

The table below presents the technical assistance service contract envisaged.

Table 17-5: Technical assistance service contract for project implementation

Item	Details
Contract subject	Consultant for providing technical assistance for project management
Contract budget	EUR 300,000
Type of contract procedure	International Open Tender

Source: GIZ/MLPS

Besides the technical assistance service, two other service contracts will be needed for project implementation:

- Construction supervision;
- Increase of public awareness.

Table 17-6: Service contract for construction supervision

Item	Details
Contract subject	Engineer to supervise the construction of: regional landfill in Donduseni; two transfer stations in Briceni and Edinet; one sorting station in Edinet; one compositing plant in Donduseni
Contract budget	EUR 690,000
Type of contract procedure	International Open Tender

Source: GIZ/MLPS

The Engineer will be responsible for supervising the implementation of the works contracts in respect of construction of the envisaged regional facilities.

Table 17-7: Service contract for increase of public awareness

Item	Details
Contract subject	Selection of Consultant for implementation of public awareness activities
Contract budget	EUR 200,000
Type of contract procedure	International Open Tender

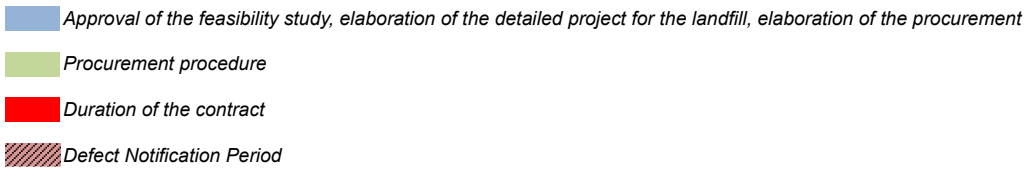
Source: GIZ/MLPS

The main tasks of a qualified public awareness Consultant will consist of increasing the public support for the introduction of the new integrated waste management system in WMZ 8.

The tables below present the project implementation schedule.

Table 17-8: Project implementation schedule

Contracts/Activities	2017		2018				2019				2020				2021				2021			
	Q. III	Q. IV	Q. I	Q. II	Q. III	Q. IV	Q. I	Q. II	Q. III	Q. IV	Q. I	Q. II	Q. III	Q. IV	Q. I	Q. II	Q. III	Q. IV	Q. I	Q. II	Q. III	Q. IV
APROVAL OF THE FEASIBILITY STUDY AND FINALYSING EIA PROCEDURE																						
TECHNICAL ASSISTANCE CONTRACTS - SUPPORT FOR THE PROJECT IMPLEMENTATION; SUPPERVISION OF CONSTRUCTION WORKS; INFORMATION AND AWARENESS COMPAING, PROJECT AUDIT Elaboration of the procurement documentations Procurement procedure Duration of the contracts																						
SUPPLY OF WASTE COLLECTION AND TRANSPORT EQUIPMENT Elaboration of the procurement documentation Procurement procedure Duration of the contract																						
CONSTRUCTION OF THE REGIONAL LANDFILL AND COMPOSTIONG PLANT IN DONDUSENI CONSTRUIREA DEPOZITULUI REGIONAL SI STATIEI DE COMPOSTARE DONDUSENI Elaboration of the detailed project for the landfill and the procurement documentation Procurement procedure Duration of the contract																						
CONSTRUCTRUCTION OF EDINET AND BRICENI TRANSFER STATIONS AND EDINET SORTING STATION Elaboration of the procurement documentation Procurement procedure Duration of the contract																						



Source: GIZ/MLPS