

## PLAN FOR THE TREATMENT OF THE RECYCLED, STABILISED, AND RESIDUAL FRACTION OF THE WASTE INSTALLATION AND OF THE COMPOSTING INSTALLATIONS IN THE KOSTINBROD AREA

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**ABSTRACT.** The current study covers the municipalities of the Kostinbrod Regional Waste Management Association. It includes the municipalities of Kostinbrod, Bozhurishte, Svoge, Slivnitsa, Godech, and Dragoman and aims to prepare an appropriate plan for maximum utilisation of waste fractions. Waste is perceived as an environmental, social, and economic problem, and growing consumption and "consumer" behaviour of society continue to generate large amounts of waste. The reality is that great and diverse efforts are needed to prevent waste formation. Waste also represents a loss of material resources (through metals and other recyclable materials), and at the same time it has a potential as an energy source. The challenge to waste management is great! The implementation of waste treatment activities, such as reuse and recycling, are environmentally friendly, leading to the diversion of waste from landfills.

**Key words:** waste, management, environment.

### ПЛАН ЗА ТРЕТИРАНЕ НА РЕЦИКЛИРАНАТА, СТАБИЛИЗИРАНАТА И ОСТАТЪЧНАТА ФРАКЦИЯ ОТ ИНСТАЛАЦИЯТА ЗА ТРЕТИРАНЕ НА БИТОВ ОТПАДЪК И НА ИНСТАЛАЦИИТЕ ЗА КОМПОСТИРАНЕ В РСУО - КОСТИНБРОД

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**РЕЗЮМЕ.** Настоящото проучване обхваща общините от Регионално сдружение за управление на отпадъци Костинброд. В него са включени общините Костинброд, Божурище, Своге, Сливница, Годеч и цели изготвяне на подходящ план максимално оползотворяване на отпадъчните фракции. Отпадъците се приемат като екологичен, социален и икономически проблем, а нарастващото потребление и „консуматорското“ поведение на обществото продължават да произвеждат големи количества отпадъци. Реалността е, че са необходими големи и разнородни усилия за предотвратяване на образуването им. Отпадъците представляват и загуба на материални ресурси (чрез метали и други материали, които могат да се рециклират), а в същото време имат и потенциал като енергийни източници. Предизвикателството пред управлението на отпадъците е голямо! Прилагането на дейностите по третиране на отпадъци като повторна употреба и рециклиране са благоприятни за околната среда, водещи до отклоняване на отпадъци от депата.

**Ключови думи:** отпадък, управление, околна среда.

## Introduction

Waste is perceived as an environmental, social, economic problem and the growing consumption and "consumer" behaviour of society continues to generate large amounts of waste. The reality is that great and diverse efforts are needed to prevent their formation. Waste represents a loss of material resources (through metals and other recyclable materials) and at the same time it has a potential as an energy source. The challenge for waste management is great! The implementation of waste treatment activities, such as reuse and recycling, are environmentally friendly, leading to the diversion of waste from landfills.

The Waste Management Act (WMA) introduces the requirements of the Waste Framework Directive 2008/98/EU into Bulgarian legislation and regulates measures and control for the protection of the environment and human health by preventing or reducing the harmful effects of waste generation and management, as well as by reducing the overall impact of

resource use and by increasing the efficiency of this use. Article 52 of the WMA requires that municipalities develop and implement waste management programs for the territory of the municipality for a period that should coincide with the period of the National Waste Management Plan and the National Waste Management Program as its essential part, and develop them in accordance with the structure, objectives, and provisions of the NWMP. In addition, the WMA requires that municipal waste management programs include the necessary measures to meet the obligations of municipalities arising from the same law.

### 1. Main steps of the process of pre-treatment of mixed collected household waste:

The pre-treatment process comprises the following main steps:

- collection of waste from the source and its transportation to the regional waste management system;
- site for unloading of waste before the next stage of separation of the fraction;

- separation of a fraction up to 80 mm in size from the total collected mixed household waste;
- separation of recyclable waste from the total collected mixed household waste;
- compacting of the already separated waste, intended for transfer to another company/organisation for recovery;
- storage of recyclable waste;
- stabilisation of the bio-degradable fraction before disposal;
- disposal of residual fractions that cannot be recovered.

By passing mixed municipal waste through a pre-treatment plant, or more precisely passing the waste through one of the processes - physical, thermal, chemical or biological, including sorting, the characteristics of the waste are changed in order to reduce its volume or their dangerous properties in order to facilitate their further treatment or to increase their gold content. According to the definition of "pre-treatment", the fulfilment of at least one of the objectives of the requirement to change the characteristics of the waste is sufficient to consider the operation as pre-treatment.

## 2. Detailed mass balance prepared on the basis of the morphological composition of the waste from all member municipalities of the Regional Association for Waste Management - Kostinbrod:

According to the Law on Waste Management, the municipalities have prepared analyses that show the morphological composition and quantities of the generated and deposited waste on their territories. Based on the prepared Detailed Mass Balance, the following table presents the forecasts for the amount of generated municipal waste by 2025 for each of the municipalities, which is part of the Regional Association for Waste Management:

Table 1a. Forecasts for the generated waste on the territory of RWMS - Kostinbrod for the period 2022-2025.

FRACTION	MUNICIPALITY OF KOSTINBROD				MUNICIPALITY OF BOZHURISHTE			
	2022	2023	2024	2025	2022	2023	2024	2025
Household waste in total	12951,78	12977,45	13003,53	13029,78	3204,46	3241,34	3279,38	3316,32
Population	16 843	16 702	16 565	16 431	8432	8441	8452	8460
Accumulation rate	769	777	785	793	380	384	388	392
Paper and cardboard	t/year 2 508,76	2 513,73	2 518,78	2 523,87	229,44	232,08	234,80	237,45
Plastic	t/year 1 839,15	1 842,80	1 846,50	1 850,23	239,37	242,13	244,97	247,73
Glass	t/year 470,15	471,08	472,03	472,98	273,34	276,49	279,73	282,88
Metal	t/year 546,57	547,65	548,75	549,86	118,57	119,93	121,34	122,70
Wood	t/year 642,41	643,68	644,98	646,28	40,70	41,17	41,65	42,12
Rubber	t/year 177,44	177,79	178,15	178,51	10,57	10,70	10,82	10,94
Textiles and leather	t/year 547,86	548,95	550,05	551,16	141,32	142,94	144,62	146,25
Hazardous household waste	t/year 306,96	307,57	308,18	308,81	2,88	2,92	2,95	2,98
Inert waste	t/year 1 616,38	1 619,59	1 622,84	1 626,12	1 119,64	1 132,52	1 145,82	1 158,72
Biodegradable waste	t/year 7721,85	7737,16	7752,70	7768,35	1158,73	1172,07	1185,82	1199,18
Green waste	t/year 1 831,38	1 835,01	1 838,70	1 842,41	588,34	595,11	602,09	608,88

As can be seen from the data provided on the composition of the waste, the goals of reducing the amount deposited by at

least 50% of the input plant will be achieved with the construction of the pre-treatment plant.

Based on the morphological analyses, a forecast mass balance of waste has been prepared, which shows the indicative quantities of waste that will fall at the entrance of the installation, which in turn determines the capacity of the installation.

Table 1b. Forecasts for the generated waste on the territory of RWMS - Kostinbrod for the period 2022-2025 (cont'd).

FRACTION	MUNICIPALITY OF DRAGOMAN				MUNICIPALITY OF SLIVNITSA			
	2022	2023	2024	2025	2022	2023	2024	2025
Household waste in total	2173,73	2178,88	2177,82	2176,38	2591,57	2583,06	2570,93	2561,70
Population	4994	4952	4905	4858	8 758	8 639	8 513	8 399
Accumulation rate	435	440	444	448	296	299	302	305
Paper and cardboard	t/year 276,72	277,37	277,24	277,05	343,12	342,00	340,39	339,17
Plastic	t/year 101,30	101,54	101,49	101,42	297,77	296,79	295,40	294,34
Glass	t/year 119,77	120,06	120,00	119,92	174,93	174,36	173,54	172,91
Metal	t/year 26,30	26,36	26,35	26,33	316,69	315,65	314,17	313,04
Wood	t/year 135,21	135,53	135,46	135,37	116,88	116,50	115,95	115,53
Rubber	t/year 17,82	17,87	17,86	17,85	4,15	4,13	4,11	4,10
Textiles and leather	t/year 83,69	83,89	83,85	83,79	101,59	101,26	100,78	100,42
Hazardous household waste	t/year 17,61	17,65	17,64	17,63	10,88	10,85	10,80	10,76
Inert waste	t/year 400,40	401,35	401,15	400,89	399,88	398,57	396,69	395,27
Biodegradable waste	t/year 1448,79	1452,22	1451,52	1450,56	1336,47	1332,08	1325,83	1321,07
Green waste	t/year 721,46	723,17	722,82	722,34	557,45	555,62	553,01	551,02

Table 1c. Forecasts for the generated waste on the territory of RWMS - Kostinbrod for the period 2022-2025 (cont'd).

FRACTION	MUNICIPALITY OF GODECH				MUNICIPALITY OF SVOGE			
	2022	2023	2024	2025	2022	2023	2024	2025
Household waste in total	2122,15	2102,11	2084,38	2067,59	6449,36	6398,97	6343,23	6288,15
Population	4750	4661	4571	4485	19633	19274	18935	18604
Accumulation rate	447	451	456	461	338	332	335	338
Paper and cardboard	t/year 228,56	226,40	224,49	222,68	1 000,94	993,12	984,47	975,92
Plastic	t/year 226,01	223,87	221,99	220,20	828,10	821,63	814,47	807,40
Glass	t/year 155,77	154,29	152,99	151,76	351,49	348,74	345,71	342,70
Metal	t/year 60,69	60,12	59,61	59,13	125,76	124,78	123,69	122,62
Wood	t/year 60,69	60,12	59,61	59,13	474,67	470,96	466,86	462,81
Rubber	t/year 6,37	6,31	6,25	6,20	115,44	114,54	113,54	112,56
Textiles and leather	t/year 75,34	74,62	74,00	73,40	267,00	264,92	262,61	260,33
Hazardous household waste	t/year 29,29	29,01	28,76	28,53	50,55	50,55	50,11	49,68
Inert waste	t/year 460,29	455,95	452,10	448,46	650,10	645,02	639,40	633,85
Biodegradable waste	t/year 1146,17	1135,35	1125,77	1116,71	4194,02	4161,25	4125,00	4089,18
Green waste	t/year 581,04	575,56	570,70	566,11	1 231,18	1 221,56	1 210,92	1 200,41

**Analysis for each of the fractions (by type of waste) that are expected to be separated as a result of the operation of the pre-treatment plant.** According to the National Report on the State and Protection of the Environment, the household waste submitted for recovery represents approximately 1/3 of the generated quantities on

the territory of the country, while those for disposal are at 70 percent (Fig. 1).

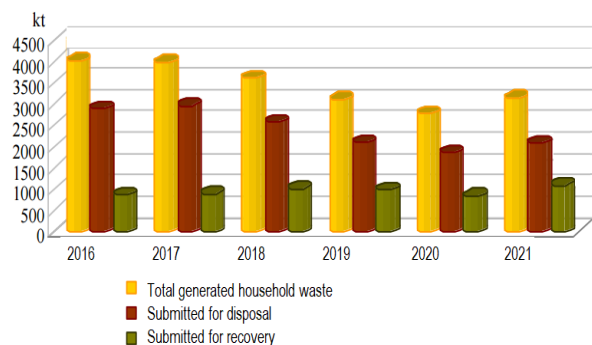


Fig. 1. Share of treated waste on average for the country, compared to the generated waste

According to the latest Eurostat data on the level of material recycling of municipal waste for Europe (EU - 28) and those for the country, it is clear that we are approaching the European average (Fig. 2).

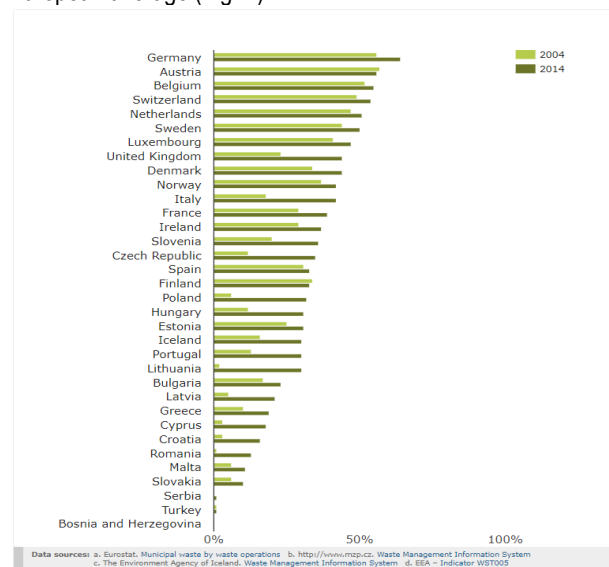


Fig. 2. Municipal waste recycling in 34 European countries (2004 and 2014)

"Proper" management of municipal waste changes waste management practices. The benefits are not limited to more efficient use of resources and reducing the burden of waste on the environment. Waste management is also a tool to reduce greenhouse gases emitted by landfills as a result of an increase in the share of recovered waste and a decrease in the share of landfilled biodegradable waste.

The general tendencies for the country are also observed for the considered region, according to the presented morphological composition of the mixed household waste intended for recycling.

In connection with the high percentages of recyclable fraction available in the composition of mixed municipal waste, it follows that it is necessary to take action for its separation and recovery.

The pre-treatment plant will process the mixed household waste, marked with code 20 03 01, according to the list of waste from the Ordinance on waste classification.

The proposed technology and organisation of the site will provide an opportunity to separate the following types of waste fractions:

- paper;
- cardboard;
- PET (polyethylene terephthalate);
- LDPE (low density polyethylene);
- HDPE (high density polyethylene);
- PR (polypropylene);
- RS (polystyrene);
- PVC (polyvinyl chloride);
- Al (aluminum);
- Fe (iron);
- glass
- leather and textiles.

As a result of the operation of the installation, the following will also be separated:

- Waste organic fraction of the size of less than 80 mm;
- Rubber;
- Inert waste;
- Hazardous household waste.

The treatment of the above, representing the next stage after the collection and transportation stage and the previous stage of recovery, will include primary waste treatment activities according to item 1, after their collection, in order to increase the amount of waste to be recovered, as well as to increase the efficiency of recovery.

The ways and techniques for the separation and treatment of the fractions are in accordance with the type of waste and the possibilities for its utilisation.

- *Dimensional sorting* is the sorting of the waste by granulometric classes. The means by which dimensional sorting is performed is a sieve with geometrically arranged openings, the diameter of which can be changed. No tools are provided for fine-grained, wet, fibrous or sticky waste. By means of such a technique, a waste organic fraction of the size of less than 80 mm will be separated;
- *Magnetic sorting* is often used for initial sorting of metal objects from other wastes, processed or not, whereby the size of the elements is not limited;
- *Sorting at the entrance* will be applied at the entrance of the installation for bulky waste, incl. and for rubber;
- *Manual sorting* is the classic method and in most cases the safest for sorting waste. It aims to separate recyclable materials, depending on the colour or type of material;
- *Stabilisation* is a process of biodegrading and stabilisation of the waste organic fraction of the size of less than 80 mm in order to meet the requirements of the regulations for stabilised organic fraction.

**Possibilities and forecasts for use or transfer for further treatment.** According to the technology for pre-treatment, large-sized waste will be separated upon receipt of mixed collected waste on the unloading site. Such waste can be tires, construction waste, household waste (when replacing furniture, etc.). Household and construction waste will be disposed of and, depending on the structure, will be transported to a landfill or processed. The tires will be temporarily stored until a sufficient amount is accumulated (one truck) and will then be

sold to companies and organisations for recycling or recovery at market prices.

According to the proposed technology and organisation of the site, opportunities can be provided for separation of the following types of waste fraction:

- paper;
- cardboard;
- PET (polyethylene terephthalate);
- LDPE (low density polyethylene);
- HDPE (high density polyethylene);
- PR (polypropylene);
- RS (polystyrene);
- PVC (polyvinyl chloride);
- Al (aluminum);
- Fe (iron);
- glass;
- leather and textiles.

This waste should be sold at market prices to companies holding the necessary permits for recycling or recovery of this waste. The leading criterion in determining the price per ton of waste will be the distance to the centre and the conditions of transportation.

The following figures indicate the points/locations of enterprises that would buy the separate recyclable fraction.

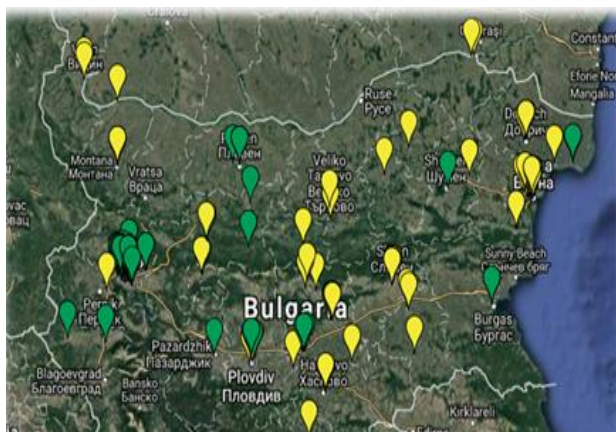


Fig. 3. Map of Bulgaria with designations of points/locations for the purchase of secondary raw materials

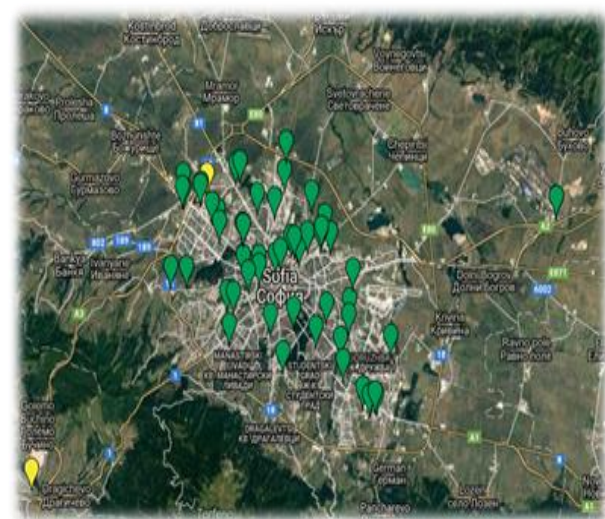


Fig. 4. Map of Sofia region with designations of points/locations for the purchase of secondary raw materials.

### 3. Stabilisation and application of fractions of up to 80 mm.

According to the "Guidelines for pre-treatment before waste disposal in the Republic of Bulgaria", approved by Order № RD - 664 of 29.08.2014 of the Minister of Environment and Water, fractions of up to 80 mm are subject to stabilisation.

Following the technology for pre-treatment of mixed municipal waste, the waste organic fraction of the size of less than 80 mm is obtained after sieving with a sieve with a hole size of 80 mm and directing the material to a machine for the separation of ferrous metals. The residual material (fine fraction of the size of 80 mm) is planned to be subjected to additional decomposition in order to meet the requirements of the regulations for stabilised organic fraction.

As a percentage of the total amount of landfilled waste, this so-called "sieve fraction" represents 35% -40% of the total amount of input plant, according to morphological analyses.

In order to reduce the amount of landfilled waste, this fraction will be stabilised by composting, according to the proposed technology. The final product of the composting process will be used to clog the landfill.

### 4. Treatment of aggregate

Aggregates are a wide range of coarse materials used in construction. Aggregates include sand, gravel, crushed stone. Much of this material will be less than 80 mm in size, so it will undergo the process of stabilising the sieve fraction.

### 5. Treatment of hazardous waste from households

A large percentage of household waste disposed of, if properly treated, does not pose a danger to human health and the environment. However, there is 1% of household waste, whose composition, quantity, or properties contain substances that pose a danger to humans and nature. This is called hazardous waste. If not disposed of, it can seriously pollute nature and endanger human health.

Hazardous waste from households that may be part of the mixed municipal waste at the entrance of the pre-treatment plant are:

- mercury and mercury-containing devices;
- lacquer and paint materials;
- household preparations and chemicals;
- inks, contaminated packaging, etc. ;
- oil filters, brake fluids and anti-freeze;
- pharmaceutical products;
- others.

A service for the disposal of the above-mentioned waste is offered by enterprises that collect directly from homes, through mobile collection points in different areas of the cities served or after the separation of hazardous waste during pre-treatment.

### 6. Treatment of residual fraction

Waste that is unfit for recycling and recovery will remain at the "exit" of the installation. Its amount will be less than 50% of the total amount of "input" pre-treatment plant. This amount is provided for the disposal of the Regional Landfill for Non-Hazardous and Inert Waste for the municipalities of Kostinbrod, Svoge, Slivnitsa, Bozhurishte, and Godech.

### 7. Control and accountability

The installation will be continuously monitored from the "entrance" to the "exit". Reporting books on the waste of the

installation, a book on the quantities and types of separated fractions, a book on those handed over for recovery and/or recycling will be kept.

## **8. Composting**

The type of composting plant is in open rows covered with a membrane and controlled aerobic system. The main goal of the construction of the composting plant is to reduce the amount of landfilled waste in general through separate collection of clean green and wood waste from public green areas, private yards, and gardens in the municipalities of the Regional Association for Waste Management - Kostinbrod.

In order to obtain quality compost, the following key elements of quality management and documentation during the work process must be strictly observed, namely:

- delivery and acceptance of incoming material;
- storage of incoming material;
- pre-treatment;
- construction of piles/rows of compost;
- control and management of the process during the fermentation stage;
- checking the quality of compost;
- documenting compost customers.

Depending on the structural material, the composting process will produce large particles that have failed to decompose during the composting process. They will be separated from the finished compost by sieving. This fraction can be used to homogenise the new batch of incoming waste and re-go through the composting process, or be transported to the Regional Landfill for landfill.

## **Conclusions**

In accordance with the national and European objectives for reducing the quantities of deposited waste and based on the presented data on their management in the municipalities of Kostinbrod Area, the following conclusions are drawn:

- It is necessary to implement a system for separate collection of green and biodegradable waste on the territory of

the municipalities and for the construction of composting plants for biodegradable and/or green waste;

- The pre-separation of the mixed collected municipal waste will separate the recoverable components from the total flow and at the same time will reduce the quantities intended for depositing. In this regard, the construction of a pre-treatment plant will also extend the service life of the existing regional landfill;

- It is necessary to take action on the treatment of construction waste in the region. The establishment of a temporary storage site will greatly facilitate their further management.

The construction of a pre-treatment installation for mixed municipal waste and composting installations, as well as proper waste management measures will contribute to reducing the environmental impacts caused by the generated waste, improving resource efficiency, increasing the responsibilities of polluters, and stimulating investment in the field of waste management.

## **References**

- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (in Bulgarian)
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (in Bulgarian)
- Guide for determining the number and type of necessary containers and machinery for waste collection and transportation, Sofia, 2011 (in Bulgarian)
- Ordinance for separate collection of bio-waste and treatment of bio-degradable waste, Promulgated, State Gazette № 20/25.01.2017 of the Constitutional Court of the Republic of Bulgaria (in Bulgarian)
- National Statistical Institute ([www.nsi.bg](http://www.nsi.bg)) (in Bulgarian)
- National Waste Management Plan 2014 – 2021 (in Bulgarian)
- Waste Management Act, Promulgated, State Gazette № 53/13.06.2012, amended by Judgment № 81/15.10.2019 of the Constitutional Court of the Republic of Bulgaria (in Bulgarian)
- European Environment Agency (<https://www.eea.europa.eu/>)