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(De)construct for Circular Economy

(Des)construir para a Economia Circular

WP 1 – Baseline situation analysis and follow-up

Activity 1.5 – Estimate of CDW illegal dumping

Final report

3rd Period

November 2022

Operador do Programa: REPÚBLICA PORTUGUESA AMBIENTE E AÇÃO CLIMÁTICA

Promotor: cimbal COMUNIDADE INTERMUNICIPAL DO BAIXO ALENTEJO

Parceiros: LNEG, NOVA SCHOOL OF SCIENCE & TECHNOLOGY, POLITÉCNICO DE PORTALEGRE, RESIALENTEJO E.I.M., Smart Waste Portugal, RDF CONSTRUÇÕES SOCIEDADE IMOBILIÁRIA, LDA., cercibeja, IDN, ENVIROS

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Conceptualization and methodological criteria; training; monitoring work supervision; data analysis, treatment and validation; report

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Operador do Programa: REPÚBLICA PORTUGUESA AMBIENTE E AÇÃO CLIMÁTICA

Promotor: cimbal

Parceiros:

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1. Introduction

The main objective of the **(De)construct for Circular Economy** project [in Portuguese: **(Des)construir para a Economia Circular**] is to promote a regional strategy for the reuse of building products and components as well as to promote the recycling of construction and demolition waste (CDW), thus reducing the environmental impact of the construction sector and promoting its circularity.

Within Work Package (WP) 1 – Baseline situation analysis and follow-up, this report aims to present the final results of Activity 1.5 – Estimate of CDW Illegal Dumping. Although WP 1 was led by the Polytechnic Institute of Portalegre, the work developed within Activity 1.5 was assigned to be entirely executed by NOVA School of Science and Technology, NOVA University Lisbon (FCT NOVA).

The reality of CDW illegal dumping is an important challenge to the Portuguese municipalities since they must deal often with this reality in their territories, in terms of environmental and landscaping impacts, but also due to the knowledge gap regarding the costs that they may have to support with cleaning actions, namely with their human resources and equipment. This is particularly relevant when waste management facilities are scarce or the transport costs are not competitive or affordable because of the distances involved (APA, 2018; European Commission, 2017; Martinho *et al.*, 2013), and this is the case of *Baixo Alentejo* region. Also, there were no systematized and consistent records about the illegal dumping of CDW in the region and, in this situation, the project aimed to contribute to the resolution of this issue.

In a later stage, this activity involved testing the implementation of specific local strategies to encourage the municipalities to be involved in actions, under their responsibility, regarding CDW management. This task was developed together with the municipal technicians and, in general, with micro and small construction companies, because specific constraints and challenges have been identified before for these types of stakeholders, about CDW legal procedures and good practices compliance (Ramos & Martinho, 2022, 2021; APA, 2018; European Commission, 2015).

These strategies also had the objective of raising awareness and training the stakeholders, in strict articulation with WP 7 – Information, Awareness, and Training (led by FCT NOVA), but moreover having in mind the reduction of the CDW illegal dumping, this process being initiated during the project, but hopefully with results to be replicated and improved in the future.

To address and present the obtained results in Activity 1.5, this report is structured in the following chapters:

- Introduction (current chapter);
- Main considerations about the monitoring period (chapter 2), presenting a brief information about the preparation and implementation of the monitoring work, as well as information about the in-person involvement from *Baixo Alentejo* municipalities, concerning training and supervision actions;
- Results (chapter 3), which details the results of illegal dumping of CDW, the strategies to encourage CDW management, but also the comparison between the CDW illegal dumping expected and observed;
- Conclusions (chapter 4), which presents a synthesis of the main results;

- References.

Also, Annexes presents photographs registrations exemplifying the monitoring work executed involving the CDW illegal dumping (Annex I), and the implementation of the mentioned local strategies (Annex II).

2. Main considerations about the monitoring period

First, this chapter presents the main considerations for **CDW illegal dumping monitoring** in the municipalities of *Baixo Alentejo* region, in Portugal, between March 2021 and October 2022 (results presented in subchapter 3.1). Second, it frames and presents the results regarding the implementation of **specific local strategies to encourage CDW management under municipal supervision**, with a focus between May and October 2022 (results presented in subchapter 3.2), trying to understand better the reality of local initiatives, but also attempting to benefit the region in terms of reducing the CDW illegal dumping (assessment presented in subchapter 3.3). Bearing in mind the objectives described above, the fieldwork was implemented during the project considering the following concerns:

- Preparation and implementation of the monitoring work;
- Supervision of the monitoring work.

2.1. Preparation and implementation of the monitoring work

2.1.1. Preparation of the monitoring work

Monitoring of CDW dumpsites

Previously to the monitoring work about the CDW illegal dumping, a methodological report was prepared (FCT NOVA, 2021a) and specific meetings were performed with the *Baixo Alentejo* municipalities, in February 2021, and with two or three municipalities at each time, in order to present the monitoring criteria to this activity, but also to clarify doubts.

Local strategies to encourage CDW management

Preparation work and encouragement to test specific local strategies, at a municipal level, were implemented between November 2021 and February 2022, in order to raise awareness regarding the importance of mitigate the CDW illegal dumping in the region, and also in order to capacitate the municipalities with the tools to face knowledge gaps identified about CDW management legal procedures and good practices.

2.1.2. Implementation of the monitoring work

CDW dumpsites monitoring

After the preparation period, and in order to allow municipal technicians of *Baixo Alentejo* region to perform the monitoring work itself, with the established criteria, individualized instructions were given every month to the municipal representatives assigned to the project (through via videoconference meetings, *e-mails,* and also by telephone). The data recorded onsite was sent, in a monthly basis, to FCT NOVA by each municipality, using a *Microsoft Excel* database prepared for this purpose. The information was analysed and, when necessary, corrections were made. After that, a new version of the document, with corrections, suggestions,

and/or questions was sent again to each municipality, asking for new monitoring data, until day 15 of each month.

Regarding the first monitoring period (March 2021), it was established, together with *Baixo Alentejo* municipalities, that the focus will be the test of the methodological approach proposed by FCT NOVA. This period was extended for another month, until April 2022. This was due to the fact that it was the first time that these municipalities performed this type of monitoring work, but also due to the Covid-19 pandemic situation, during which FCT NOVA could not join the operational representatives of the project, helping them, in a face-to-face approach, to overcome the difficulties regarding the tasks implementation and harmonizing the monitoring criteria among all the municipalities. The monitoring work continued until October 2022.

Local strategies to encourage CDW management

After perceiving the importance of the CDW illegal dumping reality, FCT NOVA tried to involve all *Baixo Alentejo* region municipalities to test specific local strategies, under municipal supervision, in order to encourage better CDW management. However, it was only possible to involve part of them. This involvement included meetings with municipal technicians, but also municipal political representatives, and a period of testing comprehended between January and April 2022, where the municipalities that have decided to get involved had a final opportunity to continue the monitoring work or not. The lack of involvement was due to unavailability of human resources, in some cases, but also due to the tasks being considered very time-consuming. It was also a difficulty the perception that this task involves more proactivity from municipalities. In general, the monitoring work was developed between May and October 2022, although some municipalities have started to implement some strategies before.

In the described context, four specific local strategies were tested in *Baixo Alentejo* region, involving municipal technicians and micro and small construction companies, namely:

- Preliminary CDW storage under municipal responsibility;
- Awareness and supervision actions on construction sites;
- Procedural control on private and public construction works;
- Communication.

Data was recorded and sent every month to FCT NOVA by each municipality, in a *Microsoft Excel* database prepared for this purpose. Data were analysed and then discussed with each municipality involved, in order to adapt the strategies, when necessary or, for instance, to implement additional training initiatives.

2.2. Supervision of the monitoring work

The monitoring work developed concerning the CDW illegal dumping, as well as the local strategies implementation, under municipal responsibility, was supervised by FCT NOVA. As explained before, in the first period, and due to the Covid-19 pandemic restrictions, it was only possible to contact municipalities through videoconference meetings, phone calls, and *e-mails*. Nevertheless, it was possible to begin the monitoring test

work. In May 2021 it was possible to supervise the monitoring work regarding the CDW illegal dumping in-person, with each municipality involved, where some adaptations to the work performed before were established, in terms of harmonizing criteria among the municipalities. This work continued, together with the complementary work and visits described below.

Regarding the presentation and subsequent supervision of the local strategies, several face-to-face visits were carried out in January, February, April, June, July, and October 2022. In general, one day was dedicated to each municipality in each of these visits, to perform and supervise the monitoring work, but also to meet with municipal technicians to form them regarding legal procedures and good practices, and also to clarify some doubts about the monitoring work itself. This work was made in strict articulation with WP 7 – Information, Awareness, and Training, led by FCT NOVA.

3. Results

3.1. Results about CDW illegal dumping

3.1.1. Main considerations

The results regarding CDW illegal dumping assessment in *Baixo Alentejo* region will be presented in the following subchapters:

- Monitored CDW dumpsites and type of site ownership (subchapter 3.1.2);
- CDW estimation assessment (subchapter 3.1.3);
- Recovery potential for CDW estimated at dumpsites (subchapter 3.1.4);
- Estimation of municipal costs related to CDW removal from dumpsites (subchapter 3.1.5).

Table 1 presents data used for the calculation of the performance indicators presented in the current chapter.

Table 1. Statistical data used for performance indicators calculation.

Municipality	Area (km^2)	Inhabitants (n.º)	Completed private construction works within a year (n.º) *
Aljustrel	459	8 140	27
Almodôvar	778	6 660	40
Alvito	265	2 468	9
Barrancos	168	1 623	8
Beja	1 147	33 340	55
Castro Verde	569	6 890	34
Cuba	172	4 547	26
Ferreira do Alentejo	648	7 807	55
Mértola	1 293	6 049	34
Moura	958	13 606	46
Ourique	663	4 545	24
Serpa	1 106	14 177	83
Vidigueira	317	5 474	N.D.
Baixo Alentejo	**8 543**	**115 326**	**441**

Sources: *Baixo Alentejo* municipalities areas and inhabitants (INE, 2020); completed private construction works (data collected from municipalities, within Activity 1.3), considering an average between 2017 and 2020 (IP Portalegre; 2021).

Legenda: * Not subject to a municipal license process or prior notification; N.D. – No Data.

Cuba municipality could not join this monitoring work. Nevertheless, the area of this municipality represents about 2% of the total area of *Baixo Alentejo* region, and it is not expected to have relevant influence in the conclusions assessed for the region.

Moreover, it is very important to be aware that it is not possible to differentiate whether the CDW dumpsites that occur in a given territory come from that same territory or from neighbouring areas. Likewise, a given territory can contribute to CDW dumpsites in its adjacent areas. These statements are valid both for the monitoring work about CDW dumpsites identification and for the CDW estimated (and respective performance indicators calculation).

Annex I present photographs that exemplify the monitoring work performed between March 2021 and October 2022.

3.1.2. Monitored CDW dumpsites and type of site ownership

Table 2 shows the number of CDW dumpsites monitored by each municipality, as well as a performance indicator, considering the number of dumpsites *per* area, presenting data for March and September 2021, and October 2022, referring to the reports established to Activity 1.5. From now on in the report, the assessment will be mainly focused on the results of the last period.

For October 2022, *Mértola, Aljustrel,* and *Ferreira do Alentejo* municipalities identified and monitored more CDW dumpsites (27, 21, and 19 sites, respectively) and *Alvito, Barrancos,* and *Vidigueira* municipalities identified a few number (3 sites each). Considering as reference the unit of 100 Km^2 area, *Aljustrel*, *Ferreira do Alentejo*, *Ourique,* and *Mértola* municipalities have more dumpsites *per* area, and *Serpa* municipality presents fewer dumpsites with the same criteria. For *Baixo Alentejo* region, 138 CDW dumpsites were registered in October of 2022, corresponding to an average of 1,6 CDW dumpsites *per* 100 km^2.

Table 2. Monitored CDW dumpsites and performance indicators (March and September 2021, and October 2022).

Municipality	CDW dumpsites					
	March 2021		September 2021		October 2022	
	nº	**Indicator** (nº/10^2 km^2)	**nº**	**Indicator** (nº/10^2 km^2)	**nº**	**Indicator** (nº/10^2 km^2)
Aljustrel	12	2,6	21	4,6	**21**	**4,6**
Almodôvar	6	0,8	7	0,9	**8**	**1,0**
Alvito	1	0,4	3	1,1	**3**	**1,1**
Barrancos	3	1,8	3	1,8	**3**	**1,8**
Beja	N.D.	N.D.	8	0,7	**10**	**0,9**
Castro Verde	4	0,7	6	1,1	**6**	**1,1**
Ferreira do Alentejo	22	3,4	19	2,9	**19**	**2,9**
Mértola	4	0,3	20	1,5	**27**	**2,1**
Moura	12	1,3	15	1,6	**16**	**1,7**

Municipality	CDW dumpsites					
	March 2021		September 2021		October 2022	
	nº	Indicator (nº/10² km²)	nº	Indicator (nº/10² km²)	nº	Indicator (nº/10² km²)
Ourique	16	2,4	17	2,6	**17**	**2,6**
Serpa	4	0,4	5	0,5	**5**	**0,5**
Vidigueira	13	4,1	3	0,9	**3**	**0,9**
***Baixo Alentejo* region**	**109**	**1,3**	**127**	**1,5**	**138**	**1,6**

Legend: N.D. – No Data
Source (*Baixo Alentejo* municipalities areas): INE (*Instituto Nacional de Estatística* – Statistics Portugal, 2020).

Another import analysis refers to the land ownership type where the CDW dumpsites occur, differentiating between public and private. The distribution in each municipality (in percentage) is presented in Figure 1, showing that in October of 2022 the majority of the CDW dumpsites occurs in public sites (68% for *Baixo Alentejo* region), except for *Almodôvar*, *Castro Verde* and *Ferreira do Alentejo* municipalities.

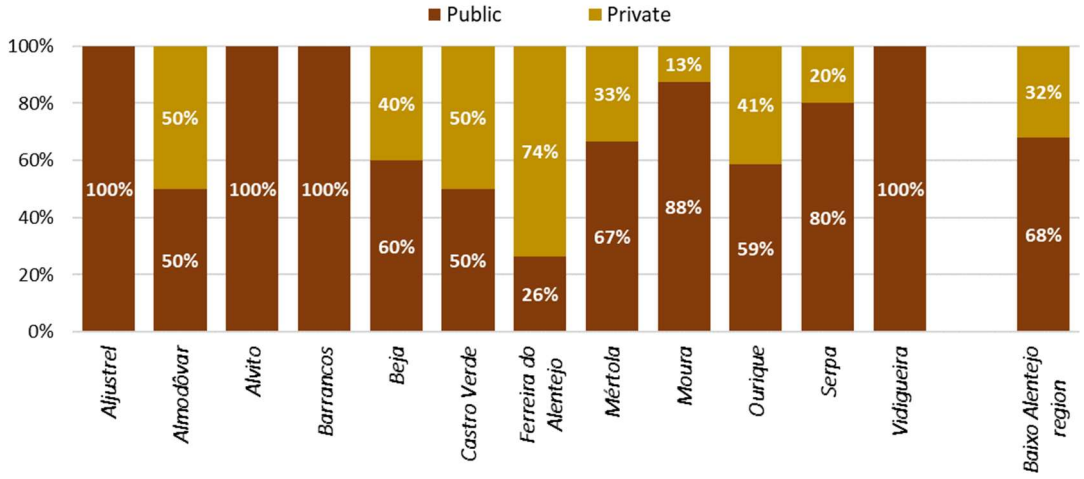


Figure 1. Type of site ownership where CDW dumpsites occur (October of 2022).

3.1.3. CDW estimation assessment

Considerations about CDW estimation

Considering the CDW estimated by the municipalities until October 2022, it is important to describe some criteria used in data treatment for justification of the results presentation, namely:

- It was only considered the CDW classified in chapter 17 of the European List of Waste (ELW)[1]; nevertheless, other waste resulting from the construction sector was registered, such as packaging waste (chapter 15 from the ELW), although in a very small quantity;
- Non-hazardous soil and stones (ELW 17 05 04), although might have a great potential for reuse, will be included in the analysis because it represents a regular problem for municipalities;
- The results were registered and presented in a cumulative approach since the main purpose was to record and study the problem regarding CDW dumpsites over time; this criterion means that, even if occurred a CDW removal from a specific dumpsite (*e.g.,* resulting from a direct cleaning action from the municipality, a contracted waste management operator, or even by a construction company, although the reason has not been identified), the record on that month (and in the subsequent months) was made considering the quantity presented before (in the month before), adding, if applicable, the new CDW abandoned at the same dumpsite;
- The quantities were estimated in volume and converted into weight through the density of the materials (see the methodological report – FCT NOVA, 2021a);
- The results are presented by ELW codes, and the values are registered in the precision of units because it is an estimation;
- In *Baixo Alentejo* region there are data regarding CDW illegal dumping removal from dumpsites involving municipalities' resources but recorded by few municipalities and not in a consistent way (*e.g.,* lack of quantities, costs, among other information), and that was the reason why these data are not evaluated in this report; nevertheless, it is a perception that the scarce results would not have influenced the findings presented.

In this subchapter it will be presented information regarding the monitoring period defined (March 2021 until October 2022), following the structure described below:

- Total CDW estimated at dumpsites;
- CDW estimated at dumpsites, by municipality;
- CDW estimated at dumpsites, by ELW codes;
- CDW estimated at dumpsites, by municipality and ELW codes.

Total CDW estimated at dumpsites

Considering the total amount of CDW reported by each municipality, Figure 2 presents the evolution of the CDW accumulated in *Baixo Alentejo* region, between the period of March 2021 and October 2022 (in volume), corresponding to 10 555 m^3. Figure 3 presents the same data but in weight, equivalent to 18 830 t.

[1] European List of Waste (ELW): Commission Decision 2014/955/EU, of 18 December, amending Decision 2000/532/EC on the list of waste, pursuant to Directive 2008/98/EC of the European Parliament and of the Council.

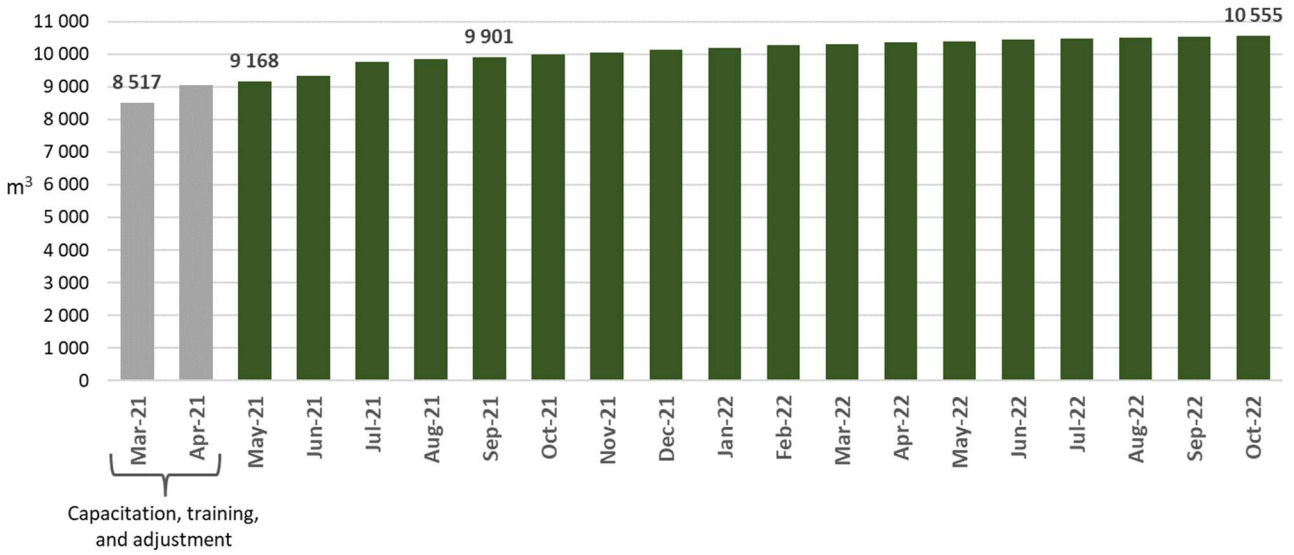


Figure 2. CDW reported in *Baixo Alentejo* region, in volume (from March 2021 until October 2022).

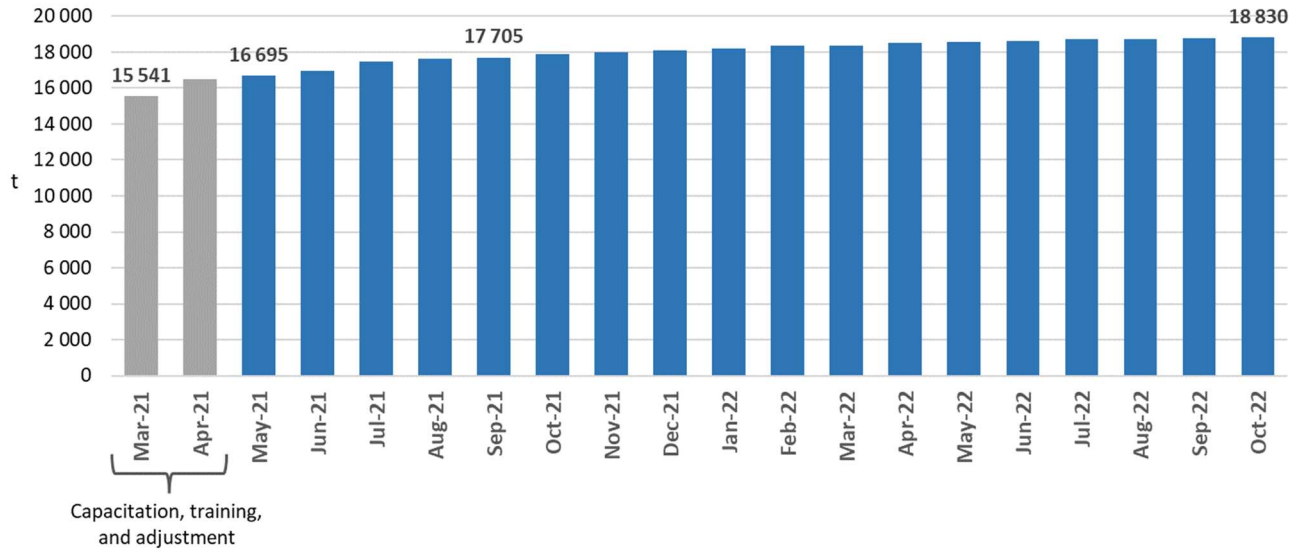


Figure 3. CDW reported in *Baixo Alentejo* region, in weight (from March 2021 until October 2022).

CDW estimated at dumpsites, by municipality

Table 3 presents the results individualized for each municipality, in volume and weight, for the reporting period of October 2022. Considering the CDW estimated *per* 100 Km^2, for *Baixo Alentejo* region the result is 124 m^3, corresponding to 220 t. If assessing the CDW estimated by 1 000 inhabitants, for the region the result is 92 m^3, corresponding to 163 t.

Table 3. CDW reported in *Baixo Alentejo* region, by municipality, and performance indicators, for October 2022

Municipality	CDW illegally dumped (October 2022)		Performance indicators (October 2022)			
	Volume (m^3)	Weight (t)	Volume		Weight	
			($m^3/10^2$ km^2)	($m^3/10^3$ inhab.)	($t/10^2$ km^2)	$t/10^3$ inhab.)
Aljustrel	121	209	26	15	46	26
Almodôvar	54	118	7	8	15	18
Alvito	533	800	201	216	302	324
Barrancos	277	499	164	171	296	307
Beja	47	85	4	1	7	3
Castro Verde	114	206	20	17	36	30
Ferreira do Alentejo	870	1 789	134	111	276	229
Mértola	7 253	12 887	561	1 199	997	2 130
Moura	660	1 151	69	48	120	85
Ourique	131	223	20	29	34	49
Serpa	403	700	36	28	63	49
Vidigueira	92	163	29	17	52	30
***Baixo Alentejo* region**	**10 555**	**18 830**	**124**	**92**	**220**	**163**

CDW estimated at dumpsites, by ELW codes

Evaluating data for *Baixo Alentejo* region, by the six digits ELW codes, the results show that mixtures of concrete, bricks, tiles and ceramics (ELW 17 01 07) is the most relevant CDW type, representing 82% of the total, in weight (Table 4).

Additionally, an area performance indicator was calculated for the region, considering the six digits ELW codes. In this context, CDW illegally dumped from the ELW code 17 01 07 is the more expressive, representing 100 m^3 *per* 100 km^2, corresponding to 180 t *per* 100 km^2.

Table 4. CDW estimated in *Baixo Alentejo* region, by ELW codes (October 2022).

EWL code		CDW estimated				Performance indicators	
		Volume		Weight		Volume	Weight
		m^3	%	t	%	(m^3/100 km^2)	(t/100 km^2)
17 01 07	Mixtures of concrete, bricks, tiles	8 532	81	15 372	82	100	180
17 05 04	Soil and stones	619	6	1 238	7	7	14
17 09 04	Mixed CDW	600	6	899	5	7	11
17 03 02	Bituminous mixtures	258	2	645	3	3	8

EWL code		CDW estimated				Performance indicators	
		Volume		Weight		Volume	Weight
		m^3	%	t	%	(m^3/100 km^2)	(t/100 km^2)
17 01 01	Concrete	119	1	238	1	1	3
17 02 01	Wood	196	2	118	1	2	1
17 01 03	Tiles and ceramics	88	1	114	1	1	1
17 01 02	Bricks	57	1	74	1	1	1
17 09 03*	Mixed CDW (hazardous)	86	1	132	1	< 0,01	< 0,01
17 03 03*	Coal tar and tarred products						
17 05 03*	Soil and stones (hazardous)						
17 06 05*	CDW containing asbestos						
***Baixo Alentejo* region**		**10 555**	**100**	**18 830**	**100**	**124**	**220**

CDW estimated at dumpsites, by municipality and ELW codes

Table 5 presents the individualized results for each *Baixo Alentejo* municipality, in volume and weight, for October 2022, considering the six digits ELW codes. Mixtures of concrete, bricks, tiles and ceramics is the most relevant type of CDW for the majority of the municipalities. In *Alvito* municipality, mixed CDW is the common fraction and for *Barrancos* municipality, soil and tones prevail.

Table 5. CDW estimated in *Baixo Alentejo* region, by municipality and ELW codes (October 2022).

Municipality	EWL code		CDW estimated (October 2022)	
			Volume (m^3)	Weight (t)
Aljustrel	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	105	189
	17 06 05*	CDW containing asbestos	8	8
	17 01 01	Concrete	3	6
	17 09 04	Mixed CDW	3	5
	17 02 01	Wood	2	1
	Total		**121**	**209**
Almodôvar	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	47	103
	17 03 02	Bituminous mixtures	5	13
	17 01 03	Tiles and ceramics	2	3
	Total		**54**	**118**
Alvito	17 09 04	Mixed CDW	520	780
	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	12	18
	17 01 01	Concrete	1	2
	Total		**533**	**800**

Municipality	EWL code		CDW estimated (October 2022)	
			Volume (m^3)	Weight (t)
Barrancos	17 05 04	Soils and stones	158	316
	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	56	101
	17 01 02	Bricks	38	49
	17 01 03	Tiles and ceramics	25	33
	Total		**277**	**499**
Beja	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	43	77
	17 05 04	Soils and stones	4	8
	Total		**47**	**85**
Castro Verde	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	47	84
	17 05 04	Soils and stones	35	69
	17 09 04	Mixed CDW	11	17
	17 01 01	Concrete	8	16
	17 01 03	Tiles and ceramics	9	12
	17 03 02	Bituminous mixtures	2	5
	17 09 03*	Mixed CDW (with hazardous substances)	2	3
	17 06 05*	CDW containing asbestos	1	1
	Total		**114**	**206**
Ferreira do Alentejo	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	401	721
	17 03 02	Bituminous mixtures	248	620
	17 05 04	Soils and stones	137	274
	17 01 01	Concrete	75	150
	17 03 03*	Coal tar and tarred products	10	24
	Total		**870**	**1 789**
Mértola	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	6 879	12 383
	17 05 04	Soils and stones	200	401
	17 02 01	Wood	173	104
	Total		**7 253**	**12 887**

Municipality	EWL code		CDW estimated (October 2022)	
			Volume (m^3)	Weight (t)
Moura	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	446	800
	17 05 04	Soils and stones	58	114
	17 01 03	Tiles and ceramics	52	68
	17 09 04	Mixed CDW	38	57
	17 01 01	Concrete	23	46
	17 09 03*	Mixed CDW (with hazardous substances)	23	35
	17 05 03*	Soils and stones (with hazardous substances)	9	18
	17 01 02	Bricks	10	13
	17 06 05*	CDW containing asbestos	1	1
	Total		**660**	**1 151**
Ourique	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	95	171
	17 09 03*	Mixed CDW (with hazardous substances)	23	32
	17 09 04	Mixed CDW	8	12
	17 01 01	Concrete	3	6
	17 06 05*	CDW containing asbestos	2	2
	Total		**131**	**223**
Serpa	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	370	666
	17 02 01	Wood	21	13
	17 01 01	Concrete	6	12
	17 09 03*	Mixed CDW (with hazardous substances)	6	9
	Total		**403**	**700**
Vidigueira	17 01 07	Mixtures of concrete, bricks, tiles, and ceramics	33	59
	17 05 04	Soils and stones	28	56
	17 09 04	Mixed CDW	19	29
	17 01 02	Bricks	9	12
	17 03 02	Bituminous mixtures	3	8
	Total		**92**	**163**
***Baixo Alentejo* region**			**10 555**	**18 830**

3.1.4. Recovery potential for CDW estimated at dumpsites

An analysis considering the potential reuse and treatment for materials existing in the CDW abandoned in *Baixo Alentejo* region is presented in Table 6. The results show that the majority could be sent for recycling, representing around 87% of the total, in weight. Around 7% has reuse potential, namely expected non-hazardous soil and rocks (to be evaluated case by case).

Table 6. Potential for reuse or treatment for the materials existing in the estimated CDW abandoned.

Potential for reuse or treatment (by type of treatment), by ELW code			CDW estimated (October 2022)	
			t	%
Reuse (to evaluate, case by case)		17 05 04	1 238	7
Recovery	Recycling (R5)	17 01 01, 17 01 02, 17 01 03, 17 01 07, 17 03 02	16 444	87
Other (to evaluate, case by case)		17 09 04, 17 02 01	1 016	5
Disposal	Landfilling (D1)	17 03 03*, 17 05 03*, 17 06 05*, 17 09 03*	132	1
***Baixo Alentejo* region**			**18 830**	**100**

Legend: 17 01 01 (concrete); 17 01 02 (bricks), 17 01 03 (tiles and ceramics), 17 01 07 (mixtures of concrete, bricks, tiles, and ceramics), 17 02 01 (wood), 17 03 02 (bituminous mixtures), 17 03 03* (coal tar and tarred products); 17 05 03* (soil and stones, with hazardous substances), 17 05 04 (soil and stones), 17 06 05* (CDW containing asbestos), 17 09 03* (mixed CDW, with hazardous substances); 17 09 04 (mixed CDW); R5 - Recycling/reclamation of other inorganic materials; D1 – Landfill disposal

3.1.5. Municipal costs estimation related to CDW removal from dumpsites

To obtain the costs related to the removal of CDW illegally dumped (most often under the responsibility of the municipalities, but also through contracted services) and its transportation to the authorized final destination (licensed waste management operators), the municipalities of *Baixo Alentejo* are not aware and do not have, in general, data to share regarding these costs. Thus, to try to raise awareness and estimate an order of magnitude for these costs, it was important to distinguish two steps:

- **Step 1**: the cost of the CDW illegal dumping removal action itself, executed by municipal employees (travel to the site, followed by the cleaning action, with CDW loading), and transportation cost for CDW delivery to a municipal controlled site for preliminary storage (perception of the option most commonly executed by the municipalities, because smaller dumpsites in terms of CDW abandonment are more frequent)[2];

[2] Assumptions (2022): i) 15 minutes to remove each t of CDW illegally dumped; ii) 3 workers to execute the work (7 €/h each); iii) municipal vehicle to employee's transportation (10 €/h); iv) backhoe/bobcat (45 €/h); v) vehicle for CDW transportation to municipal controlled site (load capacity: 5 t, since it appears to be the more frequent option in the region); vi) assumed average distances for CDW dumpsites: 5 km for municipalities with a surface up to 500 km^2 (*Aljustrel, Alvito, Barrancos,* and *Vidigueira*), 10 km for municipalities with a surface above 500 km^2 and up to 1 000 km^2 (*Almodôvar, Castro Verde, Ferreira do Alentejo, Moura, and Ourique*), and 15 km to the municipalities above this surface (*Beja, Mértola* and *Serpa*); vii) CDW transportation cost (2 €/km).

- **Step 2**: CDW transportation cost from the municipal site for CDW preliminary storage to a licensed final destination (waste management operator), with the respective payment of the treatment cost and an environmental fee, when applicable [3].

Baixo Alentejo municipalities were asked several times during the monitoring work, and since March 2021, about the reference unit values necessary to estimate the costs for removing the abandoned CDW, namely in what refers to human resources and equipment directly involved, but the responses received were scarce. In this context, the available unit values for *Baixo Alentejo* case were considered, adjusted, and complemented with other reference costs obtained in previous works carried out by the FCT NOVA (Ramos *et al.,* 2020), and market conditions consultation in 2022.

Soil and stones (non-hazardous) were excluded from the calculation since it was considered that they have a high reuse potential in most of the cases. Also, wood was not considered, because it was observed that this material disappears frequently from dumpsites, maybe because it might have other useful destinations.

In the context of the criteria explained above, Table 7 presents data referring to *Baixo Alentejo* region (also discriminated by municipality), regarding the estimation of CDW illegal dumped removal costs. For reference, 1 t of CDW removed from a dumpsite presents a cost to a municipality of *Baixo Alentejo* region around 84 €, with the cost directly assigned to the municipalities estimated around 28%.

Table 7. Estimation of CDW illegally dumped removal costs in *Baixo Alentejo* region and to each municipality.

***Baixo Alentejo* region**								
CDW		**Estimated cost (€)**						**Indicator (€/t)**
		Municipality		**Final destination** (waste management operator)			**Total**	
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	15 799	260 680	116 670	285 363	552 958	0	**1 215 672**	**77**
Bituminous mixtures	645	10 643	4 763	11 650	48 375	0	**75 430**	**117**
CDW mixtures	899	14 825	6 635	16 228	80 865	19 767	**138 321**	**154**
Hazardous CDW	132	2 174	975	7 152	26 350	2 899	**39 550**	**300**
Total	**17 474**	**288 322**	**129 042**	**320 394**	**708 548**	**22 666**	**1 468 972**	**84**

[3] Assumptions (2022): i) truck (load capacity: 15 t) for CDW transportation between the municipal controlled site (City Hall, as reference), and the preferential waste management operator; ii) transportation cost (3 €/km); iii) cost for treatment: mineral fraction (35 €/t); bituminous mixtures, non-hazardous (75 €/t); CDW mixtures, non-hazardous (90 €/t); hazardous CDW (200 €/t); iv) waste management fee, when applicable (22 €/t).

Aljustrel								
CDW		**Estimated cost (€)**						**Indicator (€/t)**
		Municipality		**Final destination** (waste management operator)			**Total**	
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	195	3 220	780	3 276	6 831	0	**14 108**	**72**
Bituminous mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
CDW mixtures	5	74	18	76	405	99	**672**	**149**
Hazardous CDW	8	132	32	403	1 600	176	**2 343**	**293**
Total	**208**	**3 427**	**830**	**3 755**	**8 836**	**275**	**17 123**	**82**

Almodôvar								
CDW		**Estimated cost (€)**						**Indicator (€/t)**
		Municipality		**Final destination** (waste management operator)			**Total**	
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	105	1 736	840	2 394	3 682	0	**8 652**	**82**
Bituminous mixtures	13	206	100	274	938	0	**1 517**	**121**
CDW mixtures	20	330	80	367	700	N.A.	**N.A.**	**N.A.**
Hazardous CDW	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
Total	**118**	**1 942**	**940**	**2 668**	**4 620**	**N.A.**	**10 169**	**86**

Alvito								
CDW		**Estimated cost (€)**						**Indicator (€/t)**
		Municipality		**Final destination** (waste management operator)			**Total**	
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	20	330	80	367	700	0	**1 477**	**74**
Bituminous mixtures	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
CDW mixtures	780	12 870	3 120	14 664	70 200	17 160	**118 014**	**151**
Hazardous CDW	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
Total	**800**	**13 200**	**3 200**	**15 031**	**70 900**	**17 160**	**119 491**	**149**

Barrancos								
CDW		**Estimated cost (€)**						**Indicator (€/t)**
		Municipality		**Final destination** (waste management operator)			**Total**	
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	183	3 015	730	7 979	6 395	0	**18 118**	**99**
Bituminous mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
CDW mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
Hazardous CDW	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**

Total	**183**	**3 015**	**730**	**7 979**	**6 395**	**0**	**18 118**	**99**

Beja

CDW		Estimated cost (€)						
		Municipality		Final destination (waste management operator)			Total	Indicator (€/t)
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	77	1 277	930	343	2 709	0	**5 259**	**68**
Bituminous mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
CDW mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
Hazardous CDW	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
Total	**77**	**1 277**	**930**	**343**	**2 709**	**0**	**5 259**	**68**

Castro Verde

CDW		Estimated cost (€)						
		Municipality		Final destination (waste management operator)			Total	Indicator (€/t)
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	111	1 838	892	1 510	3 899	0	**8 139**	**73**
Bituminous mixtures	5	83	40	61	375	0	**559**	**112**
CDW mixtures	17	272	132	224	1 485	363	**2 477**	**150**
Hazardous CDW	4	66	32	163	800	88	**1 149**	**287**
Total	**137**	**2 259**	**1 096**	**1 958**	**6 559**	**451**	**12 323**	**90**

Ferreira do Alentejo

CDW		Estimated cost (€)						
		Municipality		Final destination (waste management operator)			Total	Indicator (€/t)
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	871	14 370	6 968	12 201	30 482	0	**64 020**	**74**
Bituminous mixtures	620	10 230	4 960	8 673	46 500	0	**70 363**	**113**
CDW mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
Hazardous CDW	24	392	192	1 008	4 750	523	**6 864**	**289**
Total	**1 515**	**24 992**	**12 120**	**21 882**	**81 732**	**523**	**141 248**	**93**

Mértola

CDW		Estimated cost (€)						
		Municipality		Final destination (waste management operator)			Total	Indicator (€/t)
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	12 383	204 314	148 590	212 979	433 393	0	**999 275**	**81**
Bituminous mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
CDW mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**

Hazardous CDW	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
Total	**12 383**	**204 314**	**148 590**	**212 979**	**433 393**	**0**	**999 275**	**81**

Moura

CDW		Estimated cost (€)						
		Municipality		Final destination (waste management operator)			Total	Indicator (€/t)
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	927	15 294	7 416	22 990	32 441	0	**78 140**	**84**
Bituminous mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
CDW mixtures	57	941	456	1 414	5 130	1 254	**9 194**	**161**
Hazardous CDW	54	883	428	3 980	10 700	1 177	**17 168**	**321**
Total	**1 037**	**17 117**	**8 300**	**28 384**	**48 271**	**2 431**	**104 502**	**101**

Ourique

CDW		Estimated cost (€)						
		Municipality		Final destination (waste management operator)			Total	Indicator (€/t)
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	177	2 927	1 420	3 398	6 209	0	**13 955**	**79**
Bituminous mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
CDW mixtures	12	198	96	230	1 080	264	**1 868**	**156**
Hazardous CDW	34	553	268	1 930	6 700	737	**10 187**	**304**
Total	**223**	**3 678**	**1 784**	**5 558**	**13 989**	**1 001**	**26 010**	**117**

Serpa

CDW		Estimated cost (€)						
		Municipality		Final destination (waste management operator)			Total	Indicator (€/t)
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	678	11 187	8 136	9 221	23 730	0	**52 274**	**77**
Bituminous mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
CDW mixtures	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
Hazardous CDW	9	149	108	367	1 800	198	**2 622**	**291**
Total	**687**	**11 336**	**8 244**	**9 588**	**25 530**	**198**	**54 896**	**80**

Vidigueira

CDW		Estimated cost (€)						
		Municipality		Final destination (waste management operator)			Total	Indicator (€/t)
CDW type	Quantity (t)	Removal	Transport	Transport	Treatment	Fee		
Mineral fraction	71	1 173	284	987	2 489	0	**4 933**	**69**
Bituminous mixtures	8	124	30	105	563	0	**821**	**110**

CDW mixtures	29	470	114	399	2 565	627	**4 175**	**147**
Hazardous CDW	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	**N.A.**	**N.A.**
Total	**107**	**1 767**	**428**	**1 491**	**5 616**	**627**	**9 929**	**93**

3.2. Results about strategies to encourage CDW management by municipalities

3.2.1. Main considerations

To encourage municipalities and construction companies, specifically micro and small construction companies, to perform better and effective CDW management, complying with legal procedures and good practices, four local strategies were implemented in *Baixo Alentejo* region, together with six municipalities (*Aljustrel*, *Almodôvar*, *Castro Verde*, *Moura*, *Ourique*, and *Vidigueira*), in different combinations, according to availability and interest:

- Local Strategy 1: Preliminary storage of CDW under municipal responsibility (subchapter 3.2.2);
- Local strategy 2: Awareness and oversight actions on construction sites (subchapter 3.2.3);
- Local strategy 3: Procedural control on private and public construction works (subchapter 3.2.4);
- Local strategy 4: Communication (subchapter 3.2.5).

To evaluate the monitoring work, concerning each strategy, a 3-point ordinal scale was used to classify each aspect considered, namely: "1" (bad), if legal procedures and/or good practices assessed were not in compliance; "2" (medium), if part of legal procedures and/or good practices complied; and "3" (good) if most or the total of legal procedures and/or good practices complied. Details for each strategy are briefly described in each respective subchapter. An ordinal scale with only 3 points was used to guarantee the harmonization of criteria among the municipalities, and to try to avoid subjectivity in the perception of the evaluation executed.

These strategies implementation was supervised by FCT NOVA, who also elaborated guidelines with monitoring criteria about each one of them, as a separate document to accompany and support the actions of each municipal technician involved.

Annex II presents some photographs of the monitoring work performed, with a focus between May and October of 2022.

3.2.2. CDW preliminary storage

Four municipalities were involved in this strategy: *Almodôvar, Aljustrel, Castro Verde* and *Ourique.* The conditions offered to CDW producers in each municipality are different and criteria uniformization was not possible to be performed during the project. In these terms, the monitoring work tried to understand how to improve CDW management at a municipal scale, in terms of controlling CDW delivery by waste producers on these sites or equipment under municipal responsibility.

The results presented reflect the CDW received by each municipality during 2021 and 2022, considering a quarter analysis, but also the pre-accorded conditions with each municipality (*i.e.,* some municipalities agreed to test this strategy only in one site, for instance). Also, an evaluation regarding CDW separation was performed, in average values, because this represents an important constraint to the municipalities (*i.e.,* the CDW mineral fraction is more affordable in terms of cost of treatment than CDW mixtures). However, there were a few implemented good practices regarding the CDW reception control and the separation in the municipal sites or equipment. In this case, an effort was made to evaluate this situation and to achieve some progress during the project and specifically throughout the implementation of the strategy.

Results are present in figures, for each municipality (in alphabetical order), namely: *Aljustrel* (Figure 4), *Almodôvar* (Figure 5); *Castro Verde* (Figure 6), and *Ourique* (Figure 7). In general, the following main conclusions (linking each municipality, between parentheses, when applicable) were achieved:

- When conditions exist to deliver CDW to controlled sites (*Almodôvar* and *Castro Verde*), or equipment as *multibenne* containers (*Aljustrel* and *Ourique*), under municipal responsibility, CDW producers, namely individuals or those construction companies responsible, in general, to smaller scale construction works, adopt the habit to deliver CDW to the municipality;
- The CDW producers habit mentioned above might not differ if a tariff is applicable (Aljustrel, even the value might not be enough to support municipal total expenses with this waste stream management – until the end of 2021), or not applicable (*Almodôvar, Castro Verde,* and *Ourique*);
- If a political decision suddenly shifts the strategy followed by the municipality, the CDW received might reduce significatively (*Aljustrel*, where construction companies executing construction works without prior control were allowed to request *multibenne* containers until the end of 2021, paying the respective tariff, but this service was abandoned in 2022, allowing just the reception of CDW arising from small repairs and minor do-it-yourself construction and demolition activities, in accordance to the current legal procedures); it was not possible during the project to perceive with certainty if there are more illegal CDW dumping occurrences (in the municipality itself or contiguous municipalities) or, for instance, a transference of CDW to neighbour municipalities controlled sites (*e.g., Castro Verde*);
- When sites for preliminary storage are under municipal control, with supervision in the CDW reception, and with a specific communication (in-person) strategy, to raise awareness about procedures (*Almodôvar*, especially after 2022), is possible to achieve better results if only equipment (*Ourique*, with *multibenne* containers in each parish) or controlled sites exist, but without strict supervision (*Castro Verde*);
- When controlled sites for CDW preliminary storage, for some reason, abandon the supervision component (*Castro Verde*, in the last quarter of 2021, due to personal reasons of the municipal technician in charge of this task), or CDW control does not exist with criteria (*Ourique*), the risk for the municipality increases in terms of receiving CDW mixtures, less affordable in terms of cost of treatment, but also of higher amounts of CDW received;
- The main observation led to the perception that municipal sites and the equipment availability are essential conditions to encourage and improve CDW management on a local scale, although it is necessary to reinforce supervision and communication, to raise awareness and create habits, in terms of good practices, but also to capacitate about the existing legal procedures.

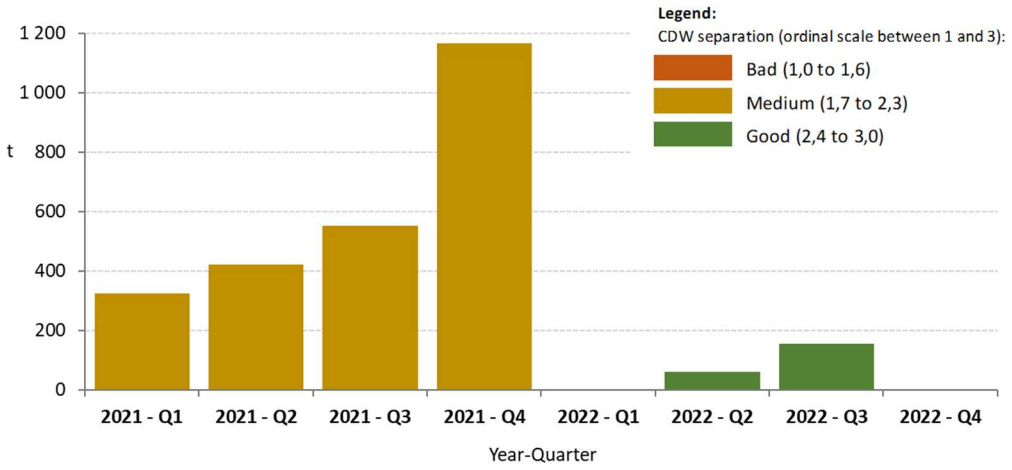


Figure 4. Preliminary storage of CDW in *Aljustrel* municipality, and evaluation about its separation.

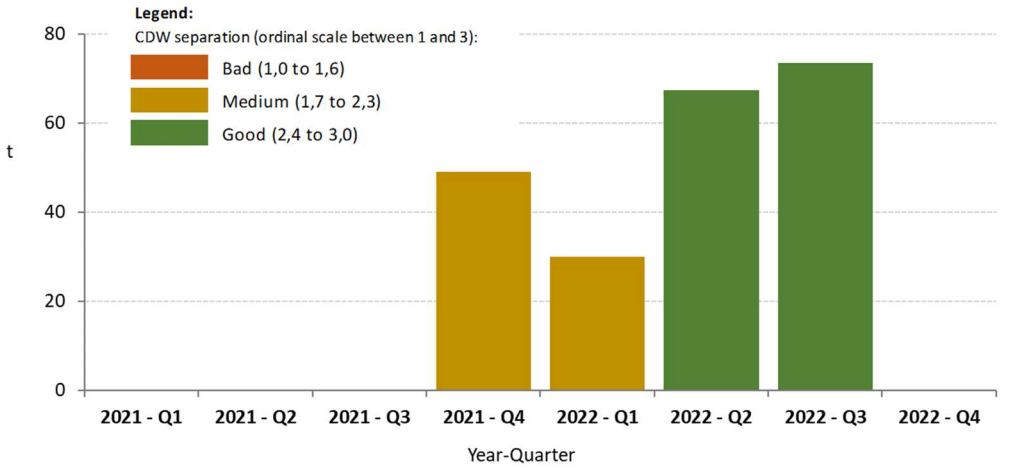


Figure 5. Preliminary storage of CDW in *Almodôvar* municipality, and evaluation about its separation.

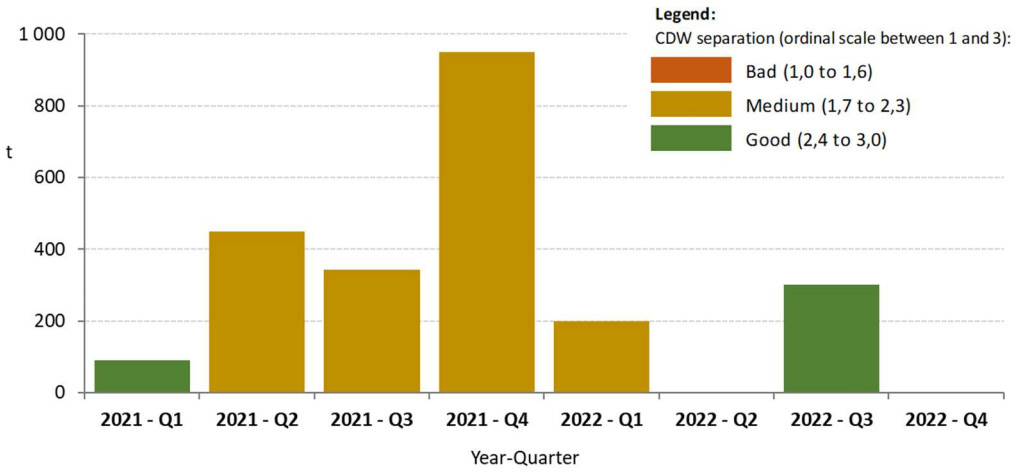


Figure 6. Preliminary storage of CDW in *Castro Verde* municipality, and evaluation about its separation.

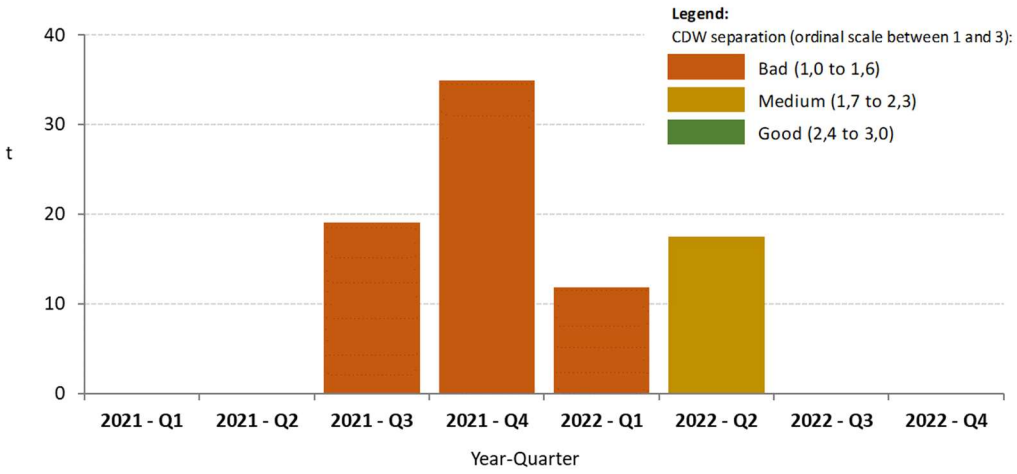


Figure 7. Preliminary storage of CDW in *Ourique* municipality, and evaluation about its separation.

3.2.3. Awareness and oversight actions on construction sites

Four municipalities were involved in this strategy (*Aljustrel, Moura, Ourique,* and *Vidigueira*), with the main objective of capacitate the municipal technicians, as well as the regional micro and small construction companies, about legal procedures and good practices about CDW management on construction sites. Municipal technicians were capacitated in terms of executing oversight actions and companies in respect to its onsite direct implementation.

The monitoring work was mainly dedicated to frequently visit private construction works subjected to control (a licensing process under municipal responsibility, or prior notification), where micro and small construction companies, with specific constraints, act more frequently. Also, these types of construction works are more

frequent in *Baixo Alentejo* region and, for this reason, municipal technicians deal often with them. Nevertheless, municipal technicians were encouraged to visit some public construction works, normally executed by medium and large construction companies, in order to contact with different realities in terms of practices and different legal procedures compliance.

Each one of the selected construction works was visited 5 times, being measured, in each visit, the respective performance concerning several aspects related to CDW management. The objective was to identify the situation on the first visit to the construction companies, and then revisit them during six months (between May and October of 2022), in order to evaluate if awareness and training onsite produce effect and encourage CDW management improvement overtime. This analysis will be presented next, in average values, differentiating private construction works subjected to prior control and public construction works.

Private construction works

For private construction works subjected to prior control (municipal licensing process or prior notification), 19 works were accompanied during the monitoring work (5 in *Moura*, 5 in *Ourique*, 5 in *Vidigueira*, and 4 in *Aljustrel*). In these cases, the main results highlight, in general, the following:

- In the first instance, and based on training and supervision executed by FCT NOVA, it was possible to train municipal technicians to execute oversight actions to construction works, to verify compliance with legal procedures and good practices, achieving the perception that now there is more knowledge, more security in implementing actions, and more motivation to continue and to achieve even better results;
- The results show (*Aljustrel* in Figure 8, *Almodôvar* in Figure 9, *Ourique* in Figure 10, and *Vidigueira* in Figure 11), in general, that it was possible to achieve improvement to compliance with legal procedures and good practices on private construction works (subjected to prior control); it is also a motivation and a challenge to try to replicate and improve these results in the future, by the same municipalities involved now, or by other municipalities that, taking into consideration these results, will want to test the same strategy;
- The observations made during the project also demonstrate that micro and small construction companies need time to adapt to new procedures that they are not used to, due to the lack of oversight actions from authorities, overtime, and also due to intrinsic characteristics, namely in terms of a lack of technical knowledge, or sometimes not understanding why to execute and how;
- For private construction works subjected to prior control, it might take more time to evolve considering hazardous CDW management, but also about bureaucratic issues, namely about onsite records referring to CDW management, with a special focus on electronic waste monitoring guides (e-GAR).

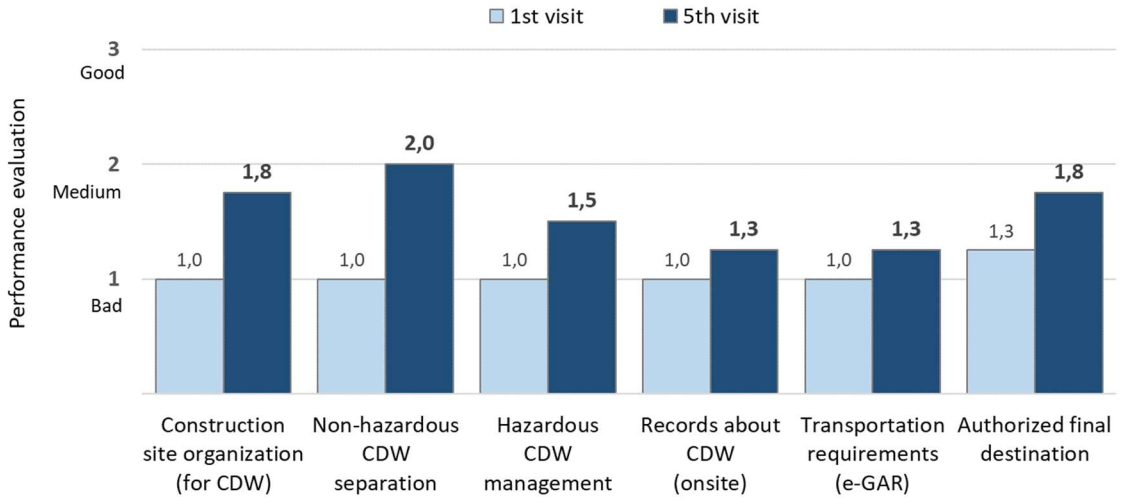


Figure 8. Awareness and supervision on private construction works, in *Aljustrel* municipality.

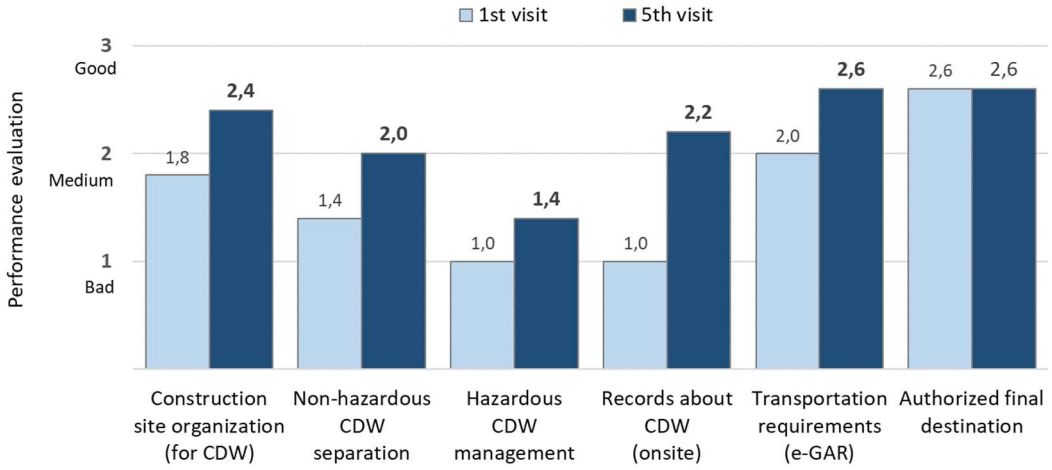


Figure 9. Awareness and supervision on private construction works, in *Moura* municipality.

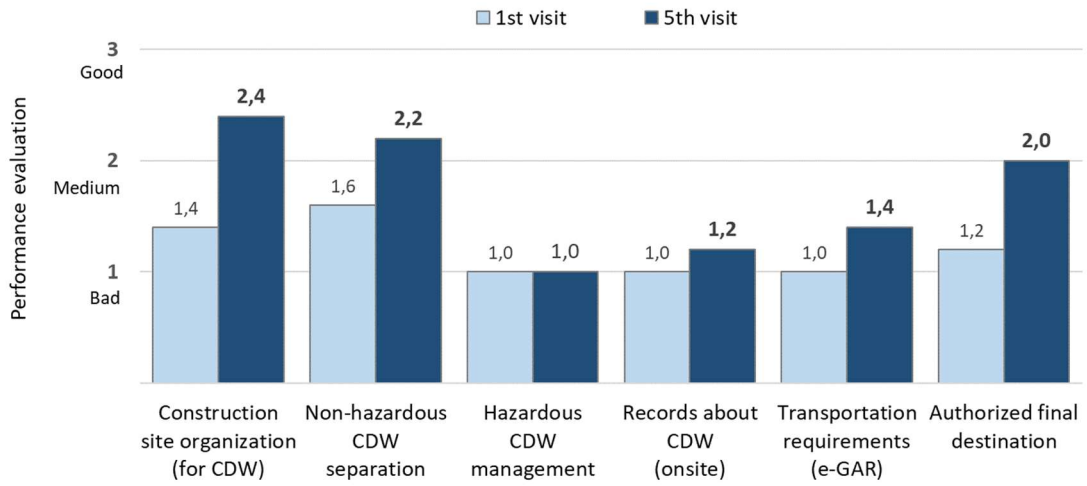


Figure 10. Awareness and supervision on private construction works, in *Ourique* municipality.

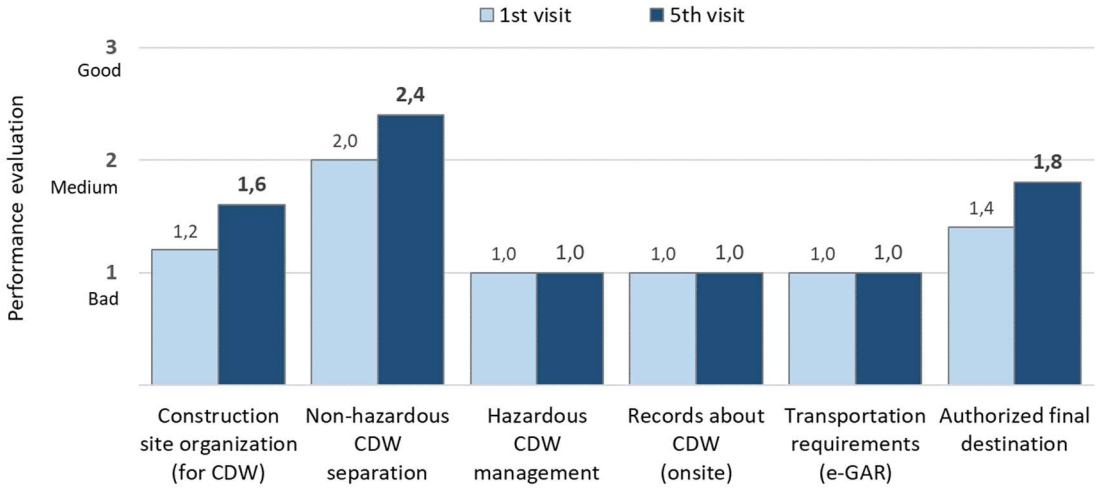


Figure 11. Awareness and supervision on private construction works, in *Vidigueira* municipality.

Public construction works

As mentioned, public construction works were not the objective of the evaluation on this task. Nevertheless, four public construction works were monitored: 2 in *Aljustrel*, 1 in *Moura*, and 1 in *Vidigueira* (Figure 12). In general, it was perceived that these companies have a better performance evaluation in terms of bureaucratic issues, as in the case of the existence of onsite records about CDW management or the use of electronic waste monitoring guides (e-GAR). Nevertheless, even for medium to large construction companies executing public construction works, the oversight actions implemented produced results in terms of positive evolution overtime.

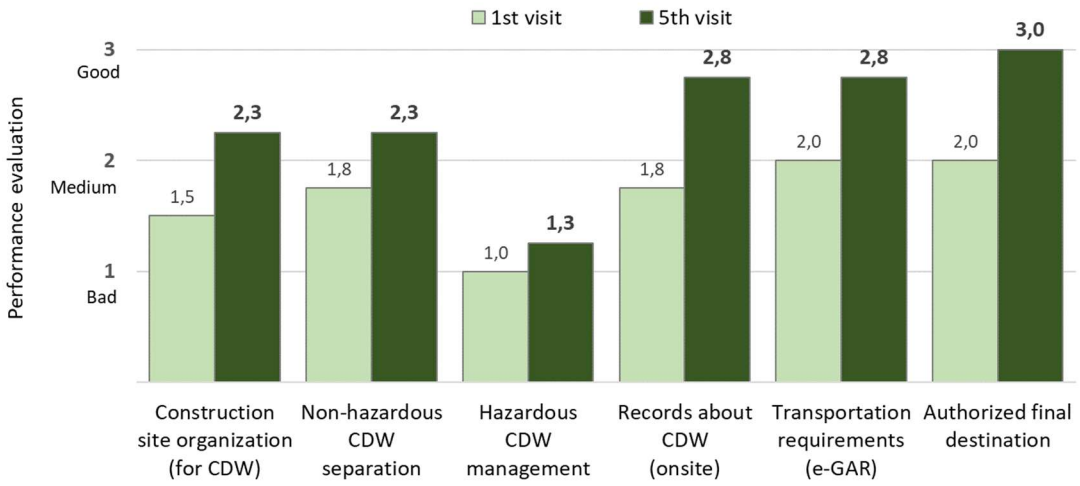


Figure 12. Awareness and supervision on public construction works, in *Aljustrel, Moura,* and *Vidigueira* municipalities.

3.2.4. Procedural control

Three municipalities were involved in this strategy: *Ourique* (for private construction works subjected to prior control), *Aljustrel* and *Almodôvar* (the last two for public construction works). The main objective of this strategy was to raise awareness of the municipal technicians to the importance of procedural control in order to achieve a better CDW management performance in a local scale dynamic. The objective was defined in these conditions, because at the start of this monitoring process it was perceived that the legal procedures have not been implemented in municipalities over the years, corroborating a general reality for several municipalities in Portugal (APA, 2018). In this context, resistance was detected, in the beginning, to proceed with the implementation of this strategy, mainly for two reasons: the first because it will be necessary to document the absence of responsibility for legal compliance; the second because there was the perception that this strategy will be more time consuming and without immediate effects. Nevertheless, the results that were possible to obtain are presented in Figure 13.

For private construction works subjected to prior control, 11 private processes were evaluated, demonstrating that in the conclusion stage (because there is only in this stage that mandatory requirements are asked in terms of procedural control), there is no evidence about CDW management. This is non-compliance by the applicants, but also from the municipalities, which do not guarantee the validity of these processes.

Regarding public construction works, 32 processes were evaluated, in two phases, regarding compliance with legal mandatory requirements: the project phase, where there is the need to present a CDW Prevention and Management Plan, correctly filled; and the conclusion phase, where is necessary to evaluate if CDW management that occurred during the construction phase is documented, but also if the expected CDW for that type of intervention was declared, of course with some margin in the analysis criteria when CDW generation indicators, or the experience of technicians in other works, were used to assess conformity. From the results (in average values), there is non-compliance by the applicants, but also from the municipalities, which do not guarantee the validity of these processes.

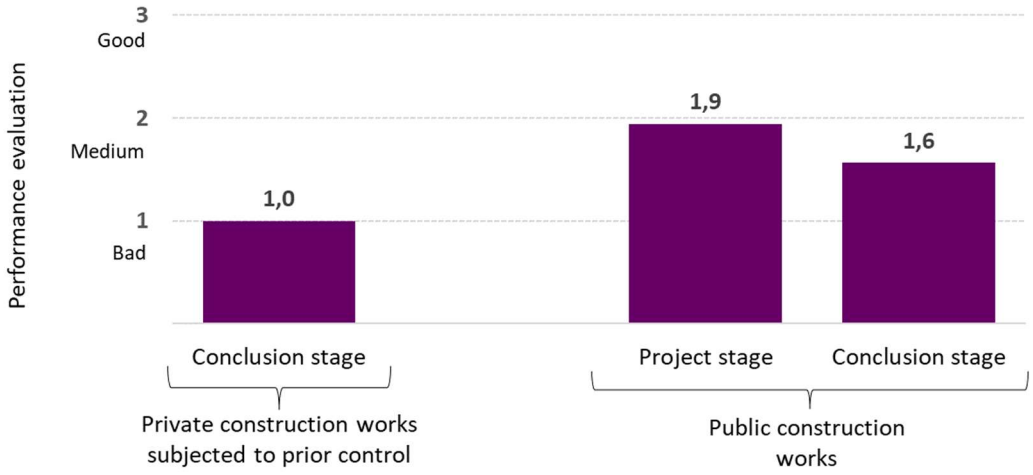


Figure 13. Procedural control in *Ourique, Almodôvar,* and *Aljustrel* municipalities.

3.2.5. Communication

A communication strategy was adopted regarding three main concerns. The first one was related to guaranteeing the implementation of the local strategies described above, raising awareness in the individuals and entities involved about the importance of communicating regarding existing legal procedures or about good practices for CDW management, to achieve better results and also to avoid penalties. There was a reinforcement of the necessity to implement preferentially direct (in-person) communication with micro and small construction companies because it was one of the main results obtained during the workshops developed within WP 7 – Information, Awareness, and Training, led by FCT NOVA (FCT NOVA, 2021b).

A second component was developed by FCT NOVA, through often training and supervision actions, which were essential to overcome the identified knowledge gaps, but also to allow the implementation of the local strategies during the project. In these terms, and although considered outside the scope of the tasks assigned to FCT NOVA (extra task), specific and detailed guidelines to implement the local strategies were developed, mainly because several knowledge gaps regarding CDW legal procedures were detected among municipal technicians at the beginning of the project. In this context, these guidelines were useful so technicians can have a document that they can consult whenever they want or need, in order to strengthen their knowledge overtime.

A third component, although also outside the tasks established within the project, was related to a proposal of text to a flyer about CDW management by individuals or construction companies, trying to harmonize criteria to *Baixo Alentejo* region, to avoid ambiguous communication, leading to companies to feel more insecure about procedures to adopt. Also, a text proposal about CDW management for the websites of municipalities was developed by FCT NOVA with the same objective (another extra task). These documents were presented to municipalities, explaining that they were extra material, but asking for feedback for improvement and/or adjustment to the necessities of the municipalities. Only five municipalities gave their feedback and that was considered.

3.3. Comparison between expected and observed CDW illegal dumping

One way to understand if the project, during its implementation, was able to achieve the specific objective of mitigating the problem regarding CDW illegal dumping, was to estimate the expected CDW abandoned and compare it to the observed CDW abandoned during the respective monitoring work. To achieve this objective, the following criteria were adopted:

- The two first months of monitoring work were not considered, because municipal technicians were testing the methodological approach suggested by FCT NOVA, and it was not possible, due to Covid-19 pandemic restrictions, to execute in-person supervision actions until May;
- After the monitoring criteria discussion, adaptation and harmonisation, six months were considered as a consolidation period for the results obtained (between May and October 2021), being measured an average monthly increment of 1,2% of CDW abandoned;
- The mentioned increment was projected for the rest of the monitoring period ("expected"), until October 2022, and then compared to the observations made by the municipal technicians ("real");
- With the criteria mentioned above, a reduction around 10% was achieved (Figure 14);
- The result obtained was perceived to be related to the fact that, during the project, municipal technicians were more frequently supervising the territory and construction companies, also implementing an information and awareness component about legal procedures, penalties, and good practices.

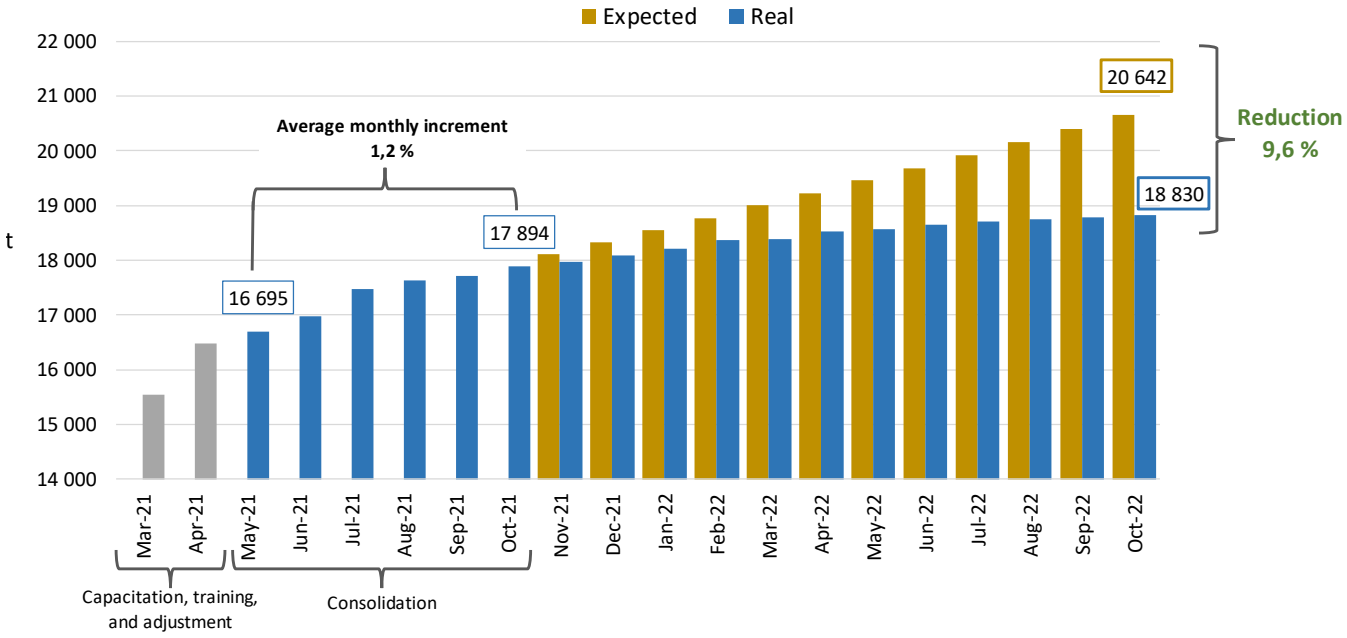


Figure 14. Illegal dumping of CDW in *Baixo Alentejo* region (expected *versus* observed).

4. Conclusions

Synthesis

The following main results for the **CDW illegal dumping** monitoring work were obtained for *Baixo Alentejo* region (Portugal), in a cumulative approach, considering the monthly records collected between March 2021 and October 2022:

- 138 CDW dumpsites were registered in the region (1,6 dumpsites *per* 100 km^2), where 68% of them are located at public-owned sites;
- A total of 10 555 m^3 of CDW was estimated, corresponding to 18 830 t; considering the total CDW estimated, a performance indicator of 220 t *per* 100 km^2 was calculated for the *Baixo Alentejo* region;
- From the total of CDW estimated at dumpsites, around 82%, in weight, corresponds to mixtures of concrete, bricks, tiles, and ceramics (ELW 17 01 07); 180 t of ELW 17 01 07 exist in every 100 km^2;
- Bearing in mind the recovery potential, around 87% of the estimated abandoned CDW can be recycled; also, 7% of soil and rocks (ELW 17 05 04) can be reused (although to be evaluated case by case);
- Regarding the costs estimation for CDW illegally dumped removal, 1 t (for reference) of CDW removed from a dumpsite presents a cost to a municipality of *Baixo Alentejo* region of 84 €; however, this analysis has to be evaluated carefully for each municipality, due to distances to waste management operators and CDW physical composition.
- It should be also noted that it is not possible to differentiate whether the CDW dumpsites that occur in a given territory come from that same territory or neighbouring areas; likewise, a given territory can contribute to CDW dumpsites in its adjacent areas.

Regarding the **local strategies to encourage CDW management**, 4 initiatives were implemented together with 6 municipalities (*Aljustrel, Almodôvar, Castro Verde, Moura, Ourique,* and *Vidigueira*):

- Regarding preliminary storage of CDW under municipal responsibility, it is a perception that it is essential to have controlled sites and equipment on a local scale, in order to reduce distances and costs, and to avoid CDW illegal dumping; these solutions must be supervised onsite and associated to the encouragement regarding CDW separation on construction sites and, by this reason, allowing to reduce the cost of treatment for municipalities;
- Concerning awareness and oversight actions to private construction works subjected to prior control, it is possible to achieve improvement in compliance with legal procedures and good practices regarding CDW management, if municipal technicians work together with micro and small construction companies; nevertheless, there are aspects that might need more time to evolve, as is the case of hazardous CDW management, and bureaucratic issues (*i.e.,* records onsite about CDW management, including electronic waste monitoring guides records – e-GAR);
- For procedural control related to private construction works subjected to prior control, or public construction works, it is essential to start the implementation of these procedures since other

strategies need this component to be effective; to accomplish this, municipal technicians need training and motivation in order to proceed;

- About the communication strategy, it is essential to perform all the strategies with communication actions, preferentially with direct communication (in-person), due to the fact that for micro and small construction companies, it is perceived as a more effective way to achieve results; also, it is necessary to harmonize the communication criteria in the region.

At the end of the project, it was possible to measure the CDW that was expected to be abandoned if the project was not running and compare it to the observations made during the monitoring work by the municipal technicians, and under the supervision of FCT NOVA. **An estimation of around 10% of reduction of CDW abandoned was achieved**, being a perception that this result was possible due to the dedication of the municipal technicians in the project, together with micro and small construction companies' engagement.

Also, it is understood that the component of information, awareness and training that was implemented, in articulation with WP 7 – Information, Awareness, and Training (led by FCT NOVA) , was essential to obtain this result. These initiatives might also have influenced the territory during the project.

Limitations

The Covid-19 pandemic situation limited the beginning of the planned monitoring work to be executed by FCT NOVA together with the municipalities. Nevertheless, this limitation has been overcome with regular online meetings, *e-mails* and phone calls between FCT NOVA and the municipal technicians, as well as during the several subsequent visits in-person to each municipality.

The lack of systematized and consistent information in *Baixo Alentejo* municipalities regarding CDW management, and complementary data (*e.g.,* for municipal CDW management costs estimation), was a constraint for the results presented.

Future initiatives

For future initiatives, it is necessary to replicate and reinforce the knowledge about the CDW illegal dumping, but also to support and motivate the implementation of local strategies to encourage better and effective CDW management on a municipal level. It is necessary to encounter regional solutions, to reduce distances and costs, but without local solutions, it will be more difficult to achieve success.

It is also time to evolve the political level since now some decisions can be take using the results achieved in this project, in order to support solutions to be implemented, specifically those mentioned in this report, related to the local scale dynamic.

References

APA (2018). *Construction and demolition waste management - summary of survey responses to Portuguese municipalities* (in Portuguese: *Gestão de resíduos de construção e demolição – resumo das respostas ao inquérito aos municípios*). Agência Portuguesa do Ambiente. Portugal. Available at (in Portuguese): https://apambiente.pt/sites/default/files/_Residuos/FluxosEspecificosResiduos/RCD/Inquerito_2018_e_compilacao.pdf

European Commission (2017). *Resource-efficient use of mixed wastes. Improving management of construction and demolition waste*. Developed for the European Commission (Directorate-General for Environment) by the consortium led by Deloitte, in partnership with BRE, ICEDD, RPS, VTT, and FCT NOVA (Nova School of Science and Technology, NOVA University Lisbon). Luxembourg: Publications Office of the European Union. Available at: https://op.europa.eu/en/publication-detail/-/publication/78e42e6c-d8a6-11e7-a506-01aa75ed71a1/language-en

European Commission (2015). *Construction and demolition waste management in Portugal*. Resource Efficient Use of Mixed Wastes. Developed for the European Commission (Directorate-General for Environment) by NOVA School of Science and Technology, NOVA University Lisbon, within the consortium led by Deloitte. Luxembourg.

FCT NOVA (2021a). *Methodology for estimating CDW illegal dumping* report. WP 1 - Baseline situation analysis and follow-up. (De)construct for Circular Economy [in Portuguese: (Des)construir para a Economia Circular] project. EEA Grants Portugal. Promoted by Comunidade Intermunicipal do *Baixo Alentejo*. Partners: LNEG – National Laboratory of Energy and Geology (Portugal); Nova School of Science and Technology – FCT NOVA (Portugal); Polytechnic Institute of Portalegre (Portugal); Smart Waste Portugal Association (Portugal); RDF Construções (Portugal); Cercibeja (Portugal); International Development Norway AS (Norway); CNPCD – National Centre for Sustainable Production and Consumption (Romania); ENVIROS s.r.o. (Czech Republic).

FCT NOVA (2021b). *Participatory Workshop – Regional strategy to promote circularity in the construction sector (construction companies) report.* WP 7 – Information, Awareness, and Training. (De)construct for Circular Economy [in Portuguese: (Des)construir para a Economia Circular] project. EEA Grants Portugal. Promoted by Comunidade Intermunicipal do *Baixo Alentejo*. Partners: LNEG – National Laboratory of Energy and Geology (Portugal); Nova School of Science and Technology – FCT NOVA (Portugal); Polytechnic Institute of Portalegre (Portugal); Smart Waste Portugal Association (Portugal); RDF Construções (Portugal); Cercibeja (Portugal); International Development Norway AS (Norway); CNPCD – National Centre for Sustainable Production and Consumption (Romania); ENVIROS s.r.o. (Czech Republic).

INE (2020). *Territorial data for the Baixo Alentejo region (municipalities)*, in Portugal. Statistics Portugal. Consulted in November 2022. Available at: https://www.ine.pt

IP Portalegre (2021). *Data collection about CDW generation and recovery and analysis of the regional construction sector dynamics report*. WP 1 - Baseline situation analysis and follow-up. (De)construct for Circular Economy [in Portuguese: (Des)construir para a Economia Circular] project. EEA Grants Portugal. Promoted by Comunidade Intermunicipal do *Baixo Alentejo*. Partners: LNEG – National Laboratory of Energy and Geology (Portugal); Nova School of Science and Technology – FCT NOVA (Portugal); Polytechnic Institute of Portalegre (Portugal); Smart Waste Portugal Association (Portugal); RDF Construções (Portugal); Cercibeja (Portugal); International Development Norway AS (Norway); CNPCD – National Centre for Sustainable Production and Consumption (Romania); ENVIROS s.r.o. (Czech Republic).

Martinho, G.; Ramos, M.; Pires, A.; Santos, P.; Gomes, A.; Moura, E. (2013). *Study for the sustainable design of a construction and demolition waste management model in the Northern Interior Region of Portugal* (in Portuguese: *Estudo para a Conceção Sustentável de Modelo de Gestão de Resíduos de Construção e Demolição, na Região Norte Interior*). Developed for Comissão de Coordenação e Desensolvimento Regional do Norte by Nova School of Science and Technology, NOVA University Lisbon. Caparica. Available at (in Portuguese): https://www.ccdr-n.pt/noticia/servicos/estudo-da-ccdr-n-propoe-reciclagem-dos-residuos-de-construcao-e-demolicao-159

Ramos, M., Martinho, G. (2022). Relation between construction company size and the use of recycled materials. *Journal of Building Engineering*, 45. https://doi.org/10.1016/j.jobe.2021.103523

Ramos, M., Martinho, G. (2021). Influence of construction company size on the determining factors for construction and demolition waste management. *Waste Management*, 136, 295–302. https://doi.org/10.1016/j.wasman.2021.10.032

Ramos, M.; Martinho, G.; Lorena, A.; Carvalho, S. (2020). *Action Plan for the Sustainable Management of Construction and Demolition Waste in Porto Metropolitan Area. Demonstration Projects. Guide for the Implementation of Demonstration Projects* (in Portuguese: *Plano de Ação para a Gestão Sustentável dos Resíduos de Construção e Demolição na Área Metropolitana do Porto. Projetos Demonstradores. Guia para a Implementação dos Projetos Demonstradores*). Developed for Área Metropolitana do Porto by NOVA School of Science and Technology (NOVA University Lisbon) and 3drivers. Available at (in Portuguese): http://portal.amp.pt/media/documents/2020/09/21/5_PD_GuiasPD_jun2020.pdf.

Annex I – Photographs exemplifying CDW illegal dumping monitoring work











Annex II – Photographs exemplifying the local strategies implementation

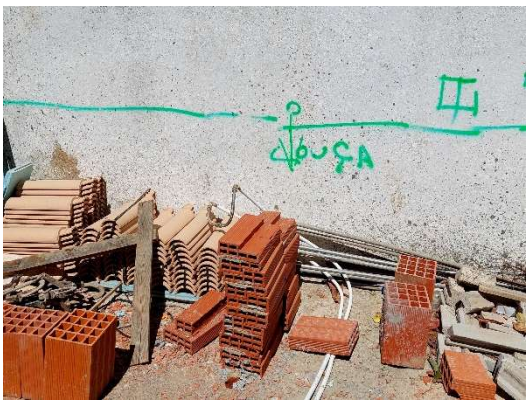
Capacitation, training and supervision

CDW preliminary storage under municipal responsibility

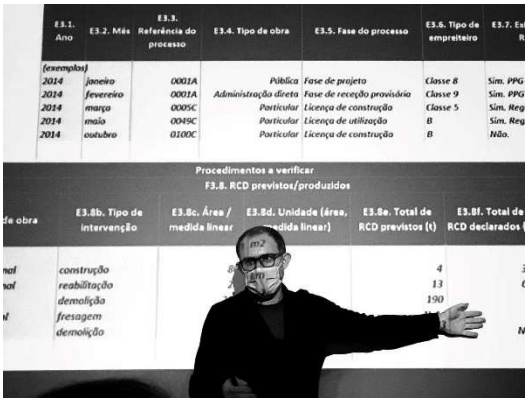
Awareness and oversight actions on construction sites





Procedural control for private and public construction works



E3.1. Ano	E3.2. Mês	E3.3. Referência do processo	E3.4. Tipo de obra	E3.5. Fase do processo	E3.6. Tipo de empreiteiro	E3.7. Es... R...
(exemplos)						
2014	janeiro	0001A	Pública	Fase de projeto	Classe 8	Sim. PPG
2014	fevereiro	0001A	Administração direta	Fase de receção provisória	Classe 9	Sim. PPG
2014	março	0005C	Particular	Licença de construção	Classe 5	Sim. Reg
2014	maio	0049C	Particular	Licença de utilização	B	Sim. Reg
2014	outubro	0100C	Particular	Licença de construção	B	Não.

Procedimentos a verificar
F3.8. RCD previstos/produzidos

de obra	E3.8b. Tipo de intervenção	E3.8c. Área / medida linear	E3.8d. Unidade (área, medida linear)	E3.8e. Total de RCD previstos (t)	E3.8f. Total de RCD declarados
	construção			4	
	reabilitação			13	
	demolição			190	
	fresagem				
	demolição