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ANALYSIS OF RENEWAL INVESTMENT NEEDS OF THE URBAN WATER CYCLE IN SPAIN

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BACKGROUND INFORMATION

When tackling the analysis of investment needs concerning the urban water cycle in Spain, experts immediately identify two main sets of actions:

- Firstly, building new constructions, that is: new infrastructures and assets. Implementing this type of actions is not only necessary based on the growing demands of society, the necessary adaptation to climate change and protection from extreme weather events, the progress towards circular economy objectives and greater security and resilience guarantees, but also on the increase in water quality requirements, both in relation to supplied flows suitable for human consumption, and discharges of used water, once treated, into receiving water bodies, so that the goal of the European Water Framework Directive (WFD) is achieved, by reaching an adequate quality level of water bodies and ensuring preservation for the future.

- Secondly, renovating the large stock of existing infrastructures and facilities, which are part of the water supply and sanitation sectors (urban drainage, sewerage and waste water treatment). Proper and beneficial maintenance and servicing are preconditions for ensuring the usefulness and effectiveness of such facilities; however, these are not sufficient to guarantee the sustainability and continuity of these infrastructures, which, ultimately, have a definite service life, thus making it necessary for experts to seek efficiency regarding the complex systems required to provide the services concerned. In addition, technical obsolescence, due to technological progress and increased demands for the preservation and quality improvement of the resource, also has an impact on the aforementioned renewal periods or service lives.

Concerns associated with the ageing of water supply and sanitation services infrastructures are becoming ever more pressing among the different stakeholders within the water sector. Consensus can be surmised around the growing need for investments aimed at covering current services and future challenges. Many aging water supply networks are deteriorated and nearing the end of their service life (Davis *et al.,* 2013). In cities such as London, about half of the water distribution network is approximately 100 years old and a third may have been even built over 150 years ago(London Assembly, 2003).

Ageing infrastructures result in a reduced installed capacity efficiency which, in turn, increases both financial and environmental costs, due to water losses and/or untreated discharges, as well as social costs, given the increased risk of system failures and service suspension. Service failures regarding the urban water cycle are far more common and impactful in climate change scenarios, which are characterised by greater intensity and a higher incidence of extreme weather events (OECD, 2014), as well as due to the population growth and concentration in urban areas (Ray and Jain, 2014). At the same time, the relevance of investment in new infrastructures that reduce the energy-intensive nature of current water allocations shall be stressed (OECD, 2014).

INTERNATIONAL SETTING

There are several studies conducted at international level, led by both public and private companies, which have performed estimates on water sector infrastructures investment needs.

Overall, the OECD (2006) estimates that investment needs concerning water services infrastructures amount to 12.48 billion dollars in OECD countries and 8.28 billion dollars in BRIC countries for the 2005-2025 period. Heymann *et al.* (2010) provide more global data, estimating a figure lower than that stated by the OECD, in which water sector investment needs, globally, are somewhere between €400-500 billion per year.

Across the European continent, according to a study by Bluefield Research (2016), the investment needs concerning water supply and sanitation infrastructures amount to 526 billion dollars for the 2016-2025 period. It is estimated that over half of this investment (256 billion dollars) will go towards the maintenance and expansion of water supply networks.

Together with global estimates, estimate regarding investment needs broken down by country are also included. Among European initiatives, special mention should be made to the study conducted by the UK Water Services Regulation Authority (Ofwat), according to which investment needs in the UK amount to 44 billion pounds, in order to improve water services and increase environmental resilience and protection between 2015 and 2020 (NAO, 2015).

In the US, according to the national survey of investment needs concerning water services infrastructures, conducted by the United States Environmental Protection Agency (EPA, 2013), investment needs for maintaining water supply services are estimated at 384.2 billion dollars, to be made over a period of 20 years (from January 2011 to December 2030). This figure includes investments in water conveyance[1] and distribution systems (52%), drinking water treatment plants (17%), storage facilities (10%) and other infrastructures necessary for ensuring public health and the social and economic welfare of the concerned populations.

In this same country, the American Society of Civil Engineers (ASCE) has supplemented the aforementioned information on US investments with estimates of investment needs for different time periods, identifying a 84.4 billion dollars investment "gap" for the 2010-2020 period, which later increases to 143.7 billion dollars for the 2020-2040 period (ASCE, 2011). Estimates of investment needs established by the Hydraulic Engineering American Association. According to this association, investment in the most urgent renewal of the water distribution and sewage network will reach one trillion dollars over 25 years and the renewal of the entire network is estimated at 2.1 trillion dollars for the same period (AWWA, 2014).

In the case of Canada, the scope of the study of investment needs is not limited to investments in water distribution (as in the above studies), but it also encompasses those in sanitation and storm water. According to a study conducted by a group of Canadian water sector entities (CCA *et al.*, 2012), the replacement value of all drinking water distribution, sanitation and storm water infrastructures amounts to 362 billion dollars, broken down as follows: 47% goes to investment in distribution, 34% to investment in sanitation and 19% to storm water management. Investment needs decrease to €56 billion if only infrastructure assets that show some signs of physical deterioration are renewed and to €15 billion when only the renewal of largely or extensively deteriorated assets is undertaken.

Among these various approaches, in addition to disparities in terms of estimated investment needs in the water sector, there are clear differences regarding the study scope (water supply, sanitation, storm water), the type of needs to be addressed (infrastructures aimed at expanding the population with access to sanitation services, new water treatment infrastructures, renewal or rehabilitation, etc.) and the methodologies applied. In the EPA study, the main source of

[1] Conveyance systems: set of infrastructures (channels or pipes) that transport abstracted water to raw water deposits or Drinking Water Treatment Plants

information used is a survey conducted among the managing bodies of all water supply systems providing service to more than 100,000 people and a representative sample of smaller systems (EPA, 2013). By means of these surveys, water supply managing bodies are directly requested to notify those projects to be carried out either to replace or rehabilitate existing or new infrastructures necessary to cover unmet needs or comply with legislation. To this end, these bodies provide documentation justifying the amount of specific investments, as well as the reasons for carrying them out.

The study conducted in Canada is also mainly based on surveys conducted among municipal service providers. As part of its methodology, a proposal for the classification of the physical condition of assets, broken down by service type, is developed. Thus, for example, regarding distribution systems, five levels are proposed, depending on the volume of network losses of water, the increase in operating costs, how close the end of the service life is, and the number of breaks per kilometre and year. In addition to physical condition, infrastructure capacity to meet demand is also analysed, suggesting a new five-level classification according to the extent to which demand equals or exceeds installed capacity. This same methodology is followed for the classification of physical condition, fulfilment of sewerage system needs and storm water management, in line with the classification proposed by various research centres, such as CERIU (Center d'expertise et de Recherche en Infrastructures urbaines), NASSCO PACP (National Association of Sewer Services Companies) and WRc (Water Research Center, Canada).

The classification of the infrastructure physical condition is based on the methodology proposed by OFWAT (2007), as defined both for linear and non-linear assets. Classifying the condition of treatment and waste water treatment plants, according to variables related to structure condition, maintenance routines, operation and maintenance of mechanical/electrical equipment of the plant, is also presented. The sewerage network condition is classified depending on network's breaks and loss of shape (Earth Tech, 2003).

SPANISH SETTING. INFRASTRUCTURE DEFICIT

Water supply and sanitation services in Spain are a matter of local competence, under the provisions provided for in Act 7/1985, of 2 April, regulating Local Regime Bases. Therefore, municipalities (over 8,000) are the owners of the services and have to manage them in accordance with principles of effectiveness and efficiency.

The Spanish legislative system provides that the management of these services may be carried out in various ways, either by direct management by local authorities, by creating public or public-private entities, or by means of service concession contracts. Moreover, different geographical areas typically centralise the management of these services (either by covering water cycle activities, or specialising in a particular area, for instance, sanitation), so that managing entities are responsible for systems that encompass more than one municipality, in order to enhance specialisation, efficiency and an economy of scale.

While this represents the general situation, and, to a large extent, it is applicable to the majority of population serviced in Spain (which is mainly concentrated in the centre and the coast of the Peninsula), the high number of municipalities (over 8,000) —most of them with a population of under 20,000 inhabitants—, coupled with geographical dispersion and different management models, makes it difficult to obtain complete and detailed information on the activities of these services, and, in particular, on renewal investment needs.

STUDIES ON INVESTMENT NEEDS. NEW NEEDS

Studies of the investment needs concerning water infrastructures in Spain have been traditionally mostly focused on specific deficits related to security of supply (infrastructures needed to ensure services, such as those for regulating water resources, installing upstream networks, water treatment plants and storage facilities) and the quality of waste water discharge (such as sanitation collection systems and waste water treatment plants).

In both cases, deficits are understood, in most cases, as a problem to be solved supramunicipally. In order to understand the reason behind this situation, it is necessary to turn to Royal Legislative Decree 1/2001, approving the recast of the Water Act. Article 17 states that:

> *State's responsibilities in relation to the public water domain are: a) Performing water planning and implementing water infrastructures State plans, or any other State plan concerned with such infrastructure [...].*

Developing the infrastructure to fulfil water demands provided for within water planning falls under the competencies of the State, or of Autonomous Communities[2] in the case of intraregional basins. Article 46 of Royal Legislative Decree 1/2001, approving the recast of the Water Act, prescribes that:

> *Only those works following the specifications set forth below shall be regarded as waterworks of public interest and a matter of National State Administration competence, regarding the basins referred to in Article 21 thereto:*
>
> *a) Those works neededto regulate and conduct water resources, with the aim of ensuring water availability and use throughout the basin [...].*
>
> *d) Those water supply, water treatment and desalination works whose implementation affects more than one Autonomous Community [...].*

Therefore, regulation works at the supramunicipal level (mainly dams and desalination plants) are considered to fall under the competence of the State and shall be incorporated into the Programmes of Measures of the River Basin Management Plans (RBMP).

On the other hand, the obligation to comply with Directive 91/271/EEC on urban waste water treatment, and the negative impacts of inadequate discharges on water bodies, which result in their deterioration and a breach of the Water Framework Directive (WFD), have made it necessary to address, from the very outset, those actions aimed at improving sanitation systems and implementing waste water treatment plants at the regional or the provincial level, with the invaluable help of river basin organisations.

This type of action has been one of the backbones of the Programmes of Measures of the RBMPs within the various river basin districts in Spain, and therefore of water investment policy. Many of these infrastructures have been built in recent years, although, in order to meet all needs (especially those related to discharge quality obligations), it is necessary to implement actions included within water plans currently in force, and recently within the *Waste Water Treatment, Efficiency, Saving and Reuse National Plan* (DSEAR Plan) developed by the Ministry for the Ecological Transition, which includes, among other things, those deficits still to be solved in this area.

[2] Autonomous Communities: official name given to the different regions in Spain.

In Spain, there have been several initiatives that have examined water investment needs to comply with the provisions of the Programmes of Measures regarding the regulation of this resource and with the obligations stemming from European policies. These studies focus on quantifying the aforementioned investments, which mostly lie outside the scope of urban legislation and shall be carried out by national and regional governments.

In this regard, the study carried out by A.T. Kearney at the request of the Spanish large-construction companies' organisation (SEOPAN) deserves special recognition. This study concludes that for Spanish water infrastructures, the investment figures (0.11% of GDP) are lower than the average European investment concerning the water cycle (0.27% of GDP). Spain has invested 56% less in infrastructure than reference countries, such as Germany, Italy, the UK and France. This report provides an overall estimate of infrastructure investment needs in Spain, which amount to a figure between €38 and €54 billion per year over the next ten years, and identifies water, along with the energy, environment, health, education, justice, communications, logistics and transport sectors, as one of the most important areas of investment (A.T. Kearney, 2015).

The study conducted by PwC (2014) on behalf of Acciona is also noteworthy; it suggests that introducing changes in the Spanish water sector regulatory framework would build sectors' confidence and result in investment being increased by €15.7 billion for the 2013-2021 period, of which over 90% (€13.7 billion) would be used for sanitation services.

Finally, according to the Spanish Confederation of Employers' Organisations, there is an immediate need to set up water cycle infrastructures, especially waste water treatment plants, in order to meet European Union requirements, with an estimated cost between €10 and €20 billion (CEOE, 2013).

Therefore, regarding "new constructions" in Spain, it can be established that, at the date of issue of this document, the needed investment is perfectly referenced and delimited for future planning cycles (until 2033). A summary can be found within the report "Summary of Spanish River Basin Management Plans. Water Framework Directive Second cycle (2015-2021)", authored by the Directorate-General forWater, within the Ministry for the Ecological Transition, and CEDEX, edited by the former. Total investment amounts to €45,192 million, and is spread over time as follows: over €19,888 million by 2021, €14,908 million for the 2022-2027 period, and €10.397 in the 2028-2033 period.

However, so far, there are no available studies assessing the renewal or replacement needs of those assets related to the urban water cycle.

SCOPE OF APPLICATION OF THE STUDY

Regarding water management, there is evidence of a lack of detailed information on the quantification, status and requirements of urban water cycle investments, understanding it as the set of infrastructures that provide service to the population and distribute water resources from large regulation infrastructures, which are subsequently collected to be treated prior to discharge.

In this case, the scope of application of the study covers the set of water treatment plants, water conveyance networks, donwstream water supply, sewerage, collectors, as well as storage facilities and waste water treatment plants (most of which are already built and whose maintenance and renewal are controlled by local or supramunicipal bodies).

These infrastructures are largely encompassed within the scope of municipal urban legislation and are essential to the sustainability and quality of services provided to 47 million locals and 80 million tourists every year, in addition to the industrial sector and other users. It should be noted that no quantification of these infrastructure investment needs is included within the Programmes of Measures of the RBMPs.

It can be concluded that a large share of these assets is not taken into account when estimating investment needs within water-related economic studies. Thus, conducting a study to analyse the renewal needs of infrastructures associated with the urban water cycle seems necessary, since there are no available national reference data.

Due to these circumstances, the Spanish Association of Water Supply and Sanitation (AEAS), which is a technical association that gathers the vast majority of water supply and sanitation service providers, the Aquae Chair in Water Economics [Cátedra Aquae de Economía del Agua] (National University of Distance Education [UNED]-Aquae Foundation [Fundación Aquae] and the research group “Engineering Science and Global Development” (EScGD), of the Civil and Environmental Engineering Department of the Catalonian Polytechnic Univeristy (UPC, in its Spanish acronym), conducted this study, in order to become more acquainted with the renewal investment needs of the urban water cycle in Spain.

GOAL AND SCOPE OF THE STUDY

The overall goal of this study is to understand the renewal investment needs concerning the urban water cycle in Spain. To achieve this objective, three specific goals were identified:

1. Performing an inventory of special infrastructures and networks that make up the integrated urban water cycle, in its current actual configuration.
2. Calculating the as-new replacement value[3] of the cost resulting from setting up all that capital.
3. Estimating the annual cost of renewal investment to sustainably maintain the capital, stemming from different scenarios based on their renewal period.

The scope of this project covers the analysis of urban water cycle investment needs, distinguishing between water supply and sanitation services. In turn, each part of the integrated water cycle is broken down into networks and special infrastructures.

Regarding networks, this study covers water conveyance, supply and sanitation networks. As for special infrastructures, Drinking water pumping stations (DWPSs), Drinking Water Treatment Plants (DWTPs), storage facilities, Waste water pumping stations (WWPSs), storm water storage tanks and Waste Water Treatment Plants (WWTPs) have been taken into account. Therefore, this study addresses both downstream water (networks, storage facilities, pumping stations and storm water storage tanks), and some infrastructures related to upstream water (DWTPs and WWTPs).

At this point, it should be clarified that this study has solely considered and assessed existing infrastructure that are currently operating (therefore, any infrastructure yet to be built has not been considered). In addition, some infrastructures could not be included in the study, mainly due to the difficulty in obtaining inventory information, to their lack of relevance regarding the total investment in Spanish urban water cycle and/or to being dependent on the central State.

Regarding its geographical scope, this study has been conducted nationwide and according to Autonomous Communities (excluding the autonomous cities of Ceuta and Melilla, which have not been included due to incompleteness of background information). In addition, whenever possible, study results are presented broken down by municipality size[4], according to the classification shown in Table 1 (which provides a detailed list of all municipalities within each stratum and their population).

According to AEAS typical classification of municipalities, the following metropolitan areas were considered in the study: Madrid, Barcelona, Valencia, Seville, Bilbao and Malaga. Consideration of these metropolitan areas was based on the fact that water supply and sanitation services in these cities are organised as systems that also operate in the nearby municipalities that make up these metropolitan areas. In order to avoid overlapping, smaller municipalities within a specific metropolitan area were removed from its corresponding stratum and incorporated into the metropolitan area one.

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[3] As-new replacement value: the replacement cost or the cost of reinstalling the current set of assets or infrastructure in its entirety at the present time.

[4] In some cases, separating municipalities with less than 20,000 inhabitants has not been possible due to lack of detailed information.

Table 1. Strata (subsets of population) accounted for in this study

STRATUM No.	DESCRIPTION	MUNICIPALITIES No.	% MUNICIPALITIES	POPULATION	% POPULATION
1	Metropolitan areas	294	4%	13,631,452	29%
2	> 100,000 inhabitants	111	1%	9,013,067	19%
3	50,001 - 100,000 inhabitants	85	1%	4,660,703	10%
4	20,001 - 50,000 inhabitants	199	2%	5,787,279	12%
5	10,001 - 20,000 inhabitants	310	4%	4,384,657	9%
6	5,001 - 10,000 inhabitants	487	6%	3,401,150	7%
7	1,001 - 5,000 inhabitants	1,773	22%	4,079,572	9%
8	< 1,001 inhabitants	4,864	60%	1,428,583	3%
Acumulado 5-8	< 20,000 inhabitants	7,434	92%	13,293,962	29%

Subsequently, this study is divided into three chapters, each aimed at covering one of the following stages of the work:

1. Performing an inventory of special infrastructures that make up the integrated urban water cycle in Spain (water supply and sanitation).
2. Calculating the as-new replacement value of the cost resulting from the deployment of all the capital presented in the inventory of networks and special infrastructures.
   The concept of as-new replacement value corresponds to the value of the hypothetical implementation, at the present time, of the existing infrastructures in use. We believe, this is the only way to appraise infrastructures and assets in order to assess renewal or replacement needs according to technical or practical criteria regarding the allocation of service lives or renewal periods.
3. Estimating the annual cost of renewal investment to sustainably maintain the capital, stemming from criteria based on their renewal period.

This study is, in any case, an analysis based on surveyed and collected data, used to perform a statistical approximation, both for the purposes of inventory and assessment, as well as of sustained annual investment needs. We estimate it is applicable to the scope or segmentation presented in the study hereto. However, obviously, each municipality or system will have both its own real inventory and its specific assessment, resulting from local conditions and conservation status; though an approach to investment needs can be made based on obtained data.

Data calculated in this study at an aggregated level can only be further adjusted and refined by conducting proper Asset Management, regarding each integrated system, or water supply or sanitation systems individually.

CHAPTER 1.
INVENTORY

The intent of this chapter is to provide an inventory of networks and special infrastructures that make up the integrated water cycle in Spain, broken down by Autonomous Communities and population strata.

Given the circumstances described in the Introduction, the heterogeneity of water management models and the multitude of service providers, it becomes imperative to base the implementation of the inventory, and its monetary quantification, on statistical techniques. This approximation is essential to obtain results at the national level.

In order to apply these techniques, different sources of information regarding the urban water infrastructure inventory have been consulted, which are detailed in the sections below. Concerning each item (networks or special infrastructures), the best source of information available was used and, whenever necessary, several sources of information were consulted, in order to obtain the most accurate possible data.

All together, regarding water conveyance, supply and sanitation networks, the length of each one is obtained, broken down by material type and diameter. Furthermore, concerning special infrastructures, the number of each type of infrastructure is obtained, as well as their main characteristic, which is an attribute of each infrastructure that allows us to characterise it, to later estimate its cost based on such characteristic.

1.1. WATER CONVEYANCE NETWORK INVENTORY

The water conveyance network inventory was obtained based exclusively on information from the AEAS National Study (2018); this information was extrapolated to the national total.

Its results, shown in Table 2, suggest that the water conveyance network in Spain is 23,789 km long. Iron is the most common material in these networks (75%), followed by fibre cement (16%) and concrete (9%). The presence of iron is particularly noticeable in municipalities with less than 20,000 inhabitants, where this material amounts to 91% of water conveyance networks. On the contrary, in larger municipalities (with more than 50,000 inhabitants) the presence of concrete increases (over 30%), and is also associated with larger pipes.

Tabla 2. Water conveyance network, broken down by material and stratum

	Total	DUCTILE IRON	FIBRE CEMENT	CONCRETE
Total	**23,789**	**17,912**	**3,820**	**2,058**
Strata:				
Metropolitan areas	2,230	1,320	235	675
> 100,000 inhabitants	1,504	435	336	732
50,000 -100,000 inhabitants	1,045	454	250	341
20,000 - 50,000 inhabitants	2,512	654	1,548	310
< 20.000 inhabitants	16,498	15,048	1,450	-

1.2. INVENTORY OF WATER SUPPLY AND SANITATION NETWORKS

Two complementary sources of information were used to obtain the inventory of water supply and sanitation networks.

On one hand, in the case of municipalities with over 20,000 inhabitants, the 15th National Study on Drinking Water Supply and Sanitation in Spain (AEAS, 2018) was used; it is based on a comprehensive survey on the main defining characteristics of urban water supply and sanitation services in Spain. This study provides data for 2016, covering a percentage of population over 78% regarding municipalities with more than 20,000 inhabitants.

On the other hand, in the case of municipalities with less than 20,000 inhabitants, where the scope of AEAS National Study (2018) is reduced (39% of the population covered), other data source was used to obtain more accurate and detailed information: Local Infrastructures and Equipment Survey (hereinafter EIEL, in its Spanish acronym) (Ministry of Territorial Policy and Civil Service, 2017). EIEL carried out a census-based national inventory, aimed at understanding the condition and the capacity of the various local infrastructures and equipment, including those related to the urban water cycle. In this context, this survey provides information on all municipalities with less than 50,000 inhabitants of the national territory, excluding the Autonomous Communities of Navarre and the Basque Country[5]. Specifically for this study, data from municipalities with a population of under 20,000 inhabitants in 2016[6] was used.

These two complementary sources of information have been combined to obtain a database that provides information for Spain as a whole, on water supply and sanitation networks total length and their percentage distribution by materials: fibre cement (FC), ductile iron (DI), concrete (CO), PVC (PC), polyethylene (PE) and other materials (OT). This information is provided in detail broken down by regions and population strata (according to the list shown in Table 1).

The resulting database provides, in the case of the water supply network, information on 90% of the municipalities (and 84% of the population) in the country. Regarding the sanitation network, percentages are 90% (for municipalities) and 70% (for population). In order to provide information throughout the national territory, information obtained was extrapolated to the national total, using the average value of the network length per stratum of population in each Autonomous Community as raising criteria[7].

Results of the inventory of water supply and sanitation networks for each material type, broken down by Autonomous Communities and population strata, are presented in Table 3 (detailed information on network length broken down by regions and population strata, jointly, is provided in Table A.1. within Appendix A., regarding the water supply network, and in Table A.2. within Appendix A, in relation to the sanitation one).

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[5] In relation to these two Autonomous Communitys, the inventory was performed exclusively based on data by AEAS (2018) for all strata of the population.

[6] Currently, EIEL offers information for 2017, but it is limited to a small number of provinces. In the case of those regions regarding which EIEL provides no data for 2016, the nearest year possible for which data is available was used.

[7] In those cases where the average value for a particular stratum of the population in a specific Autonomous Community was not available, the average value of the stratum at the national level was used.

Table 3. Inventory of water supply and sanitation networks (expressed in km) for each type of material, broken down by Autonomous Community and stratum of the population

WATER SUPPLY							
	Total	DUCTILE IRON	POLYETHYLENE	PVC	FIBRE CEMENT	CONCRETE	OTHERS
Total	**248,245**	**63,426**	**71,039**	**37,150**	**63,318**	**2,660**	**10,652**
ACs:							
Andalusia	41,868	9,238	13,393	4,934	12,335	273	1,695
Aragon	5,953	1,006	1,145	657	2,953	67	124
Asturias	8,041	1,484	3,274	1,673	1,535	3	73
The Canary Islands	13,988	2,157	4,163	1,122	915	384	5,246
Cantabria	3,123	663	1,399	472	491	9	88
Castile and Leon	20,050	2,624	5,800	6,728	4,703	39	157
Castile-La Mancha	16,393	1,184	3,265	7,694	3,934	223	92
Catalonia	28,207	6,459	8,099	2,959	8,527	668	1,495
Valencian Community	31,612	5,203	11,034	2,388	11,922	260	805
Extremadura	7,615	876	2,242	1,505	2,839	-	153
Galicia	21,093	3,570	9,336	5,059	3,051	42	36
The Balearic Islands	4,638	540	1,227	733	2,001	8	130
Madrid	18,651	15,182	765	298	1,604	448	354
Navarre	4,212	3,436	284	15	329	98	49
The Basque Country	9,877	7,173	1,535	-	1,013	119	37
Region of Murcia	10,954	2,416	2,969	877	4,557	18	117
La Rioja	1,971	216	1,109	36	608	-	1
Strata:							
Metropolitan areas	44,875	25,477	6,783	990	8,652	1,154	1,819
> 100,000 inhabitants	33,332	14,189	6,930	1,647	8,811	322	1,433
50,000 - 100,000 inhabitants	22,274	6,602	6,288	1,856	6,818	65	645
20,000 - 50,000 inhabitants	32,672	7,400	10,212	2,188	9,717	27	3,128
< 20,000 inhabitants	115,093	9,758	40,827	30,468	29,320	1,092	3,628

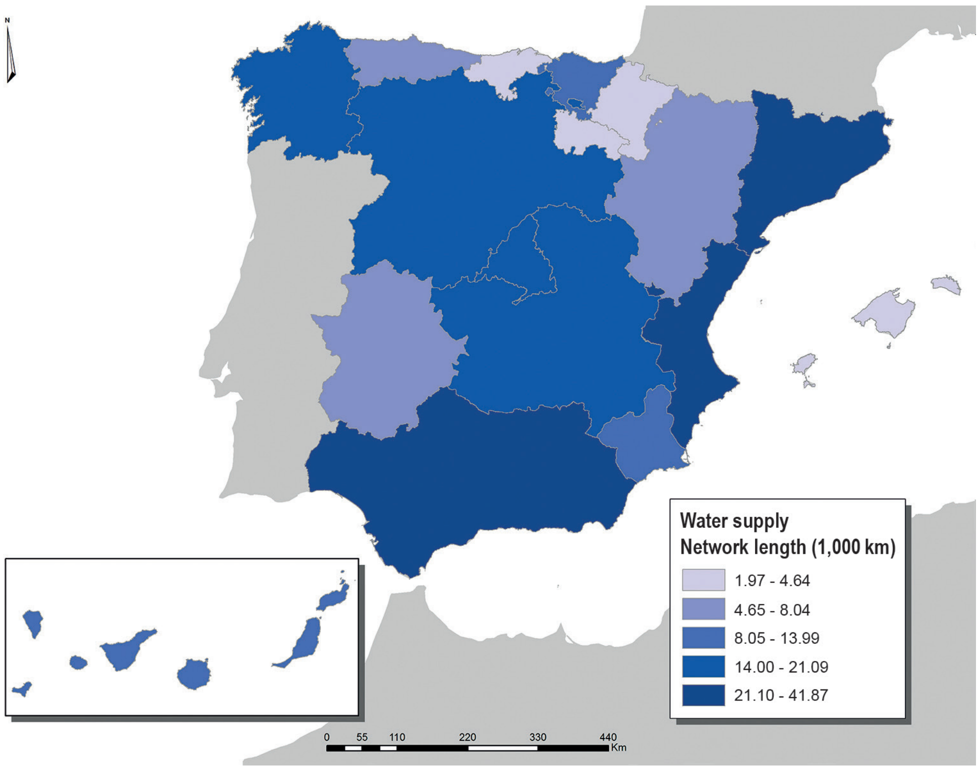
SANITATION							
	Total	DUCTILE IRON	POLYETHYLENE	PVC	FIBRE CEMENT	CONCRETE	OTHERS
TOTAL	**189,203**	**220**	**7,065**	**47,003**	**10,521**	**106,832**	**17,562**
ACs:							
Andalusia	30,883	5	1,186	7,893	1,869	17,154	2,776
Aragon	5,090	8	60	777	389	3,785	71
Asturias	3,585	11	44	1,747	114	1,345	325
The Canary Islands	5,690	21	106	2,431	256	2,190	685
Cantabria	2,416	124	34	1,029	130	996	103
Castile and Leon	16,625	-	88	3,492	1,280	11,513	252
Castile-La Mancha	11,736	-	70	2,156	215	9,162	132
Catalonia	24,913	34	2,183	3,033	2,435	13,893	3,335
Valencian Community	22,107	5	860	3,182	342	14,211	3,507
Extremadura	5,885	1	146	1,193	135	4,305	106
Galicia	18,874	9	326	9,791	2,132	5,602	1,013

(Continuation TABLE 3)

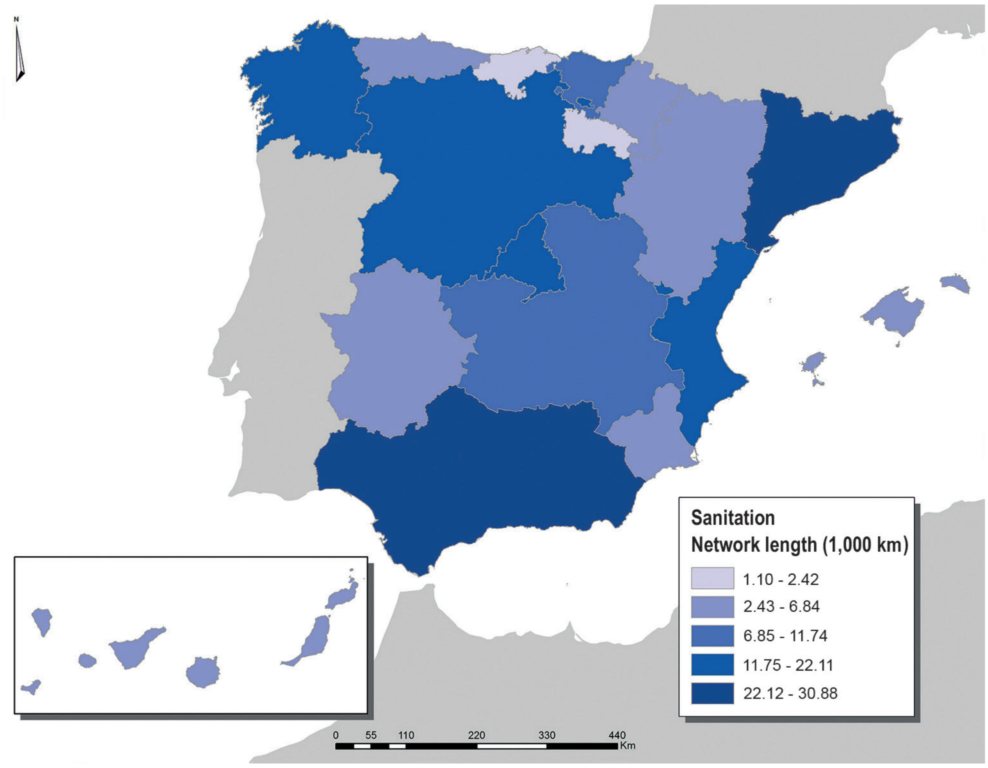
SANITATION							
	Total	DUCTILE IRON	POLYETHYLENE	PVC	FIBRE CEMENT	CONCRETE	OTHERS
The Balearic Islands	3,600	-	382	1,205	936	977	100
Madrid	17,296	-	536	1,591	35	10,551	4,583
Navarre	3,679	-	2	1,992	5	1,655	26
The Basque Country	8,878	-	742	2,888	-	4,877	372
Region of Murcia	6,845	2	301	2,141	223	4,000	178
La Rioja	1,102	-	-	462	24	615	0.5
Strata:							
Metropolitan areas	38,566	11	1,432	4,326	1,063	22,527	9,207
> 100,000 inhabitants	27,722	-	1,251	9,033	1,506	13,659	2,273
50,000 - 100,000 inhabitants	18,047	13	603	5,015	479	10,363	1,573
20,000 - 50,000 inhabitants	25,335	24	1,640	7,303	691	13,117	2,560
< 20,000 inhabitants	79,533	172	2,140	21,326	6,781	47,166	1,949

It is verified that the water supply network is 248,245 km long, while the sanitation one is 189,203 km in length. Polyethylene (28.62%), iron (25.55%) and fibre cement (25.51%) are the most common materials in water supply networks, followed by PVC (14.97%), concrete (1,07%) and other materials (4.29%). However, in the case of sanitation networks, the use of concrete is predominant (56.46%), followed by PVC (24.84%), fibre cement (5.56%), polyethylene (3.73%), iron (0.12%) and other materials (9.28%).

Table 3 and Maps 1 and 2 show the network distribution broken down by Autonomous Community.



Map 1. Water supply network length, broken down by Autonomous Community.



Map 2. Sanitation network length, broken down by Autonomous Community.

Typically, water supply and sanitation regional patterns are very similar, proving that Andalusia, Catalonia and Valencia are the Autonomous Communities with the longest networks. Conversely, La Rioja, Cantabria, Navarre and the Balearic Islands are those with the shortest networks.

In addition, the network inventory can also be classified according to strata of population, as detailed in Table 3, which shows that a higher proportion of networks is concentrated in those strata with the greatest number of inhabitants (municipalities with less than 20,000 inhabitants and metropolitan areas).

Additionally, Figures 1 and 2 show the different distribution of network materials broken down by strata of population. Figure 1 shows that, regarding the water supply network, the use of iron is far more common in metropolitan areas (where it amounts to 56.08% of the network) and it gradually decreases as the size of the municipalities is reduced, accounting for 8.80% of the network in municipalities with less than 20,000 inhabitants. The opposite is true for polyethylene, since its use in the total network increases as the size of the municipality is reduced (from 15.19% in metropolitan areas to the 35.34% in municipalities with less than 20,000 inhabitants). The remaining materials amount to a more similar percentage among the different strata of population, excluding PVC in municipalities with less than 20,000 inhabitants, which is very common (amounting to 26.37%, compared to 14.96% on average in Spain).

In the case of the sanitation network (Figure 2), there are fewer differences in network distribution according to materials. Main differences can be found in metropolitan areas, where a smaller use of PVC (amounting to 9.96% of the network, compared to 24.79% on average in Spain) and a greater presence of other materials (accounting for 25.21%, compared to 9.09% on average in Spain) are observed. In addition, it is observed that, regarding all strata, there is virtually no use of iron in the sanitation network, while the presence of concrete increases.

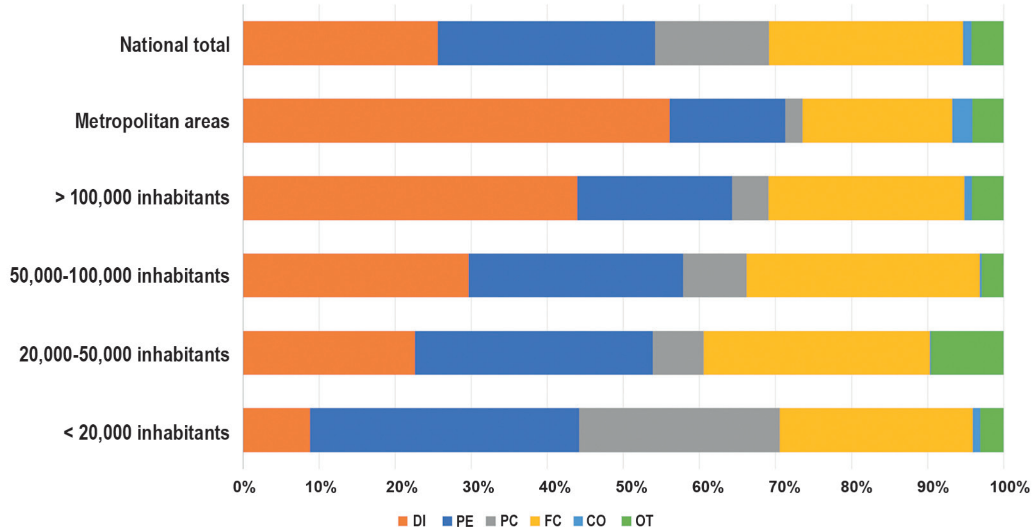


Figure 1. Water supply network distribution, broken down by material and stratum.

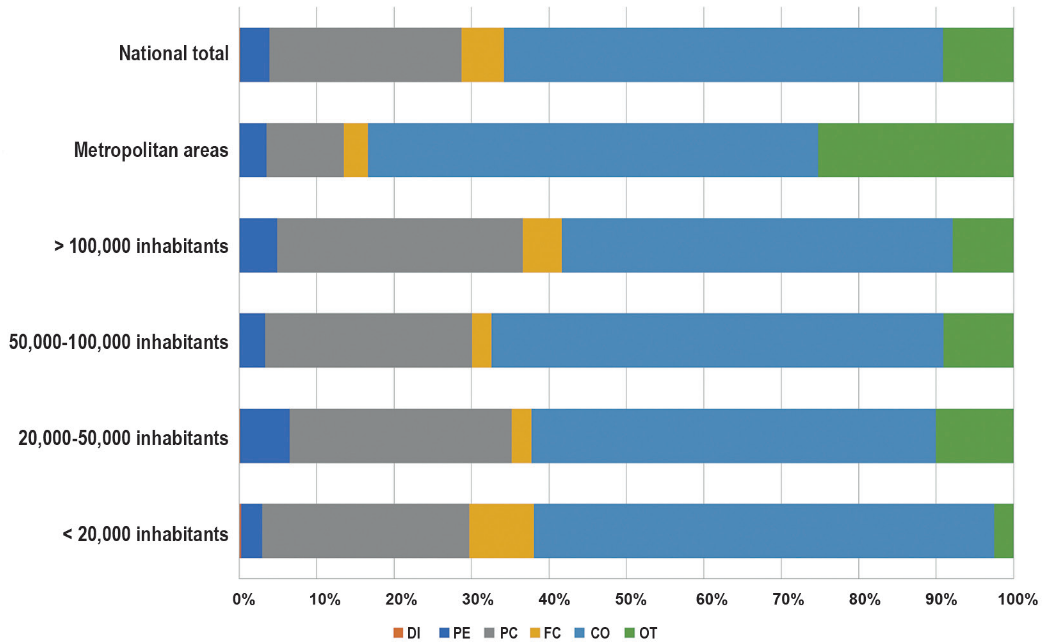


Figure 2. Sanitation network distribution, broken down by material and stratum.

Once the total length of water supply and sanitation networks in Spain is obtained, broken down by Autonomous Community, population strata and material type, each network shall be classified according to its diameter. In order to gain information on the aforementioned and other issues, a survey on the condition of water infrastructures was specifically conducted by AEAS amongst its members in 2018.

The objective of this survey was to obtain information both on the current condition of Spanish infrastructures and on the criteria followed by service providers regarding the Asset Management of Water Infrastructures, as well as on network and infrastructures renewal periods or current investment in renewal. Service providers participation covered close to 15 million serviced inhabitants.

Based on data from this survey, the network composition according to their diameters can be determined, as detailed in Table A.3. within Appendix A. Thus, regarding each type of material, the network percentage of small, medium and large diameters is known. The composition of materials classified as "other materials" is the only one unknown, it being considered as the average of known materials. Therefore, by determining the total length of each material and the percentage of the length corresponding to small, medium and large diameters, the length and diameter for each material can be determined (broken down by regions and strata of population). This length is divided by the total network length to calculate its percentage for each material type and diameter. This information shall be needed later in Chapter 2, to obtain the as-new replacement value of the new cost resulting from installing these networks.

1.3. DRINKING WATER TREATMENT PLANTS (DWTPS) INVENTORY

Information used to obtain the DWTPs inventory in Spain is based on data provided by the Spanish National Information System on Drinking Water (SINAC, in its Spanish acronym) and published by the Ministry of Health, Consumer Affairs and Social Welfare (2018). This report provides data on the number of treatments in Spain (including the number of DWTPs) and also on the percentage of treatments in each region compared to the total. The number of DWTPs per Autonomous Community is obtained by applying this percentage to the total number of DWTPs in Spain. In addition, the SINAC reports the volume of treated water (expressed in Hm3) per day in Spain, as well as the percentage each Autonomous Community amounts to. Taking into account this information, assuming DWTPs treat water 24 hours a day, the main characteristic of this infrastructure is obtained (its flow, expressed in m3 per hour); this information shall be later required in Chapter 2 to calculate the as-new replacement value of the cost resulting from installing all those DWTPs.

The next step is to separate the number of DWTPs within each Autonomous Community broken down by population strata. To this end, the AEAS National Study (2018), which provides data regarding the number of DWTPs per Autonomous Communities and population strata, was used. Based on that information, the percentage DWTPs amount to regarding each stratum of population within each Autonomous Community is calculated. Finally, this percentage is applied to the number of DWTPs within each Autonomous Community, obtained from the SINAC. This whole process has been used for each stratum of population within each Autonomous Community, excluding metropolitan areas where, thanks to AEAS information (2018), data on all existing DWTPs therein, as well as their flow, is available.

Despite the fact that using DWTPs data provided for by AEAS (2018) and extrapolating this information to the national total might seem easier at first sight, this methodology was ruled out, for two reasons. On one hand, AEAS (2018) information on DWTPs is insufficient, since it only covers 6% of municipalities (amounting to 48% of the total population in Spain). On the other, SINAC provides the total number of DWTPs. Therefore, extrapolating AEAS data (2018) was not deemed appropriate, since it could have resulted in a number of DWTPs different from that offered by SINAC. Conversely, it was decided to take SINAC data on DWWPs into account and use AEAS data (2018) to divide the number of DWTPs according to the population strata.

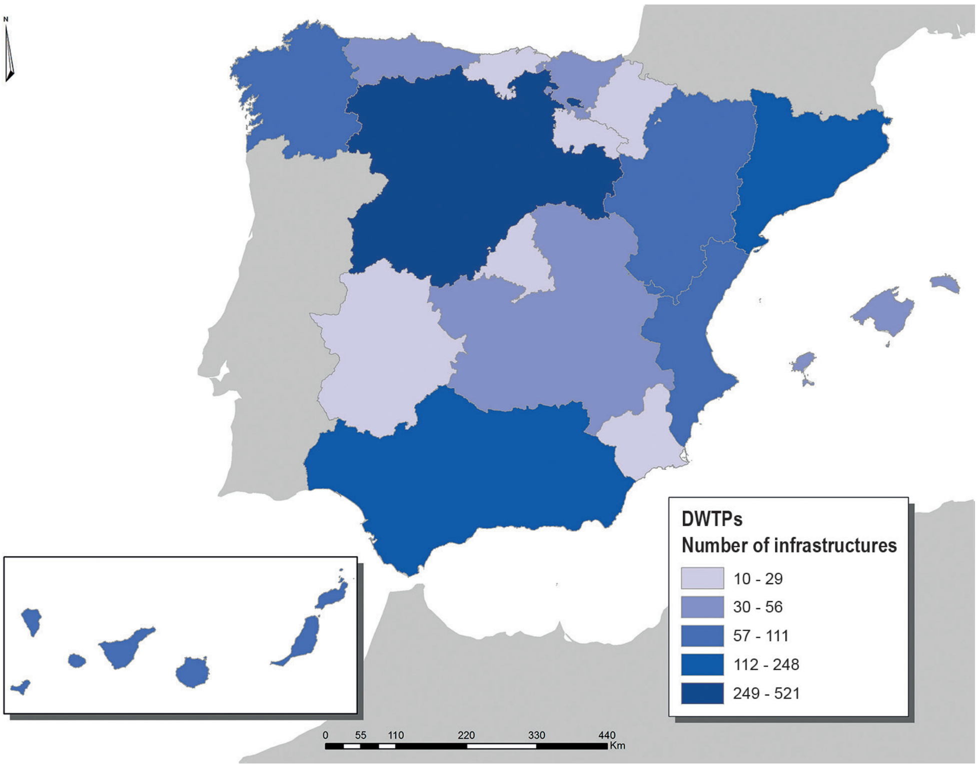
DWTPs inventory results for Spain as a whole, broken down by Autonomous Communities and population strata, are summarised in Table 4. Results detailed according to population strata and Autonomous Communities, jointly, can be found in Table A.4. within Appendix A.

In Table 4, it is apparent that the total number of DWTPs in Spain is 1,640. In addition, both Table 4 and Map 3 show the distribution of DWTPs broken down by Autonomous Communities. The largest number of DWTPs is concentrated in those Autonomous Communities with a greater number of municipalities, such as Castile-Leon, Andalusia and Catalonia (amounting to 31.77%, 15.12% and 11.65% of the total number of DWTPs in Spain, respectively). By contrast, the Autonomous Communities with a lesser number of DWTPs are Navarre, La Rioja and Madrid, since none of them exceeds 1% of the national total for the number of municipalities.

Table 4 also shows that most DWTPs are located in municipalities with less than 20,000 inhabitants (which house 87.26% of DWTPs), while the lowest percentage of DWTPs can be found in metropolitan areas (1.59%).

Table 4. DWTPs inventory, broken down by Autonomous Community and stratum

	No. DWTPs
Total	**1,640**
ACs:	
Andalusia	248
Aragon	111
Asturias	36
The Canary Islands	93
Cantabria	20
Castile and Leon	521
Castile-La Mancha	56
Catalonia	191
Valencian Community	
Extremadura	23
Galicia	88
The Balearic Islands	38
Madrid	14
Navarre	10
The Basque Country	54
Región of Murcia	29
La Rioja	13
Strata:	
Metropolitan areas	26
> 100,000 inhabitants	46
50,000 - 100,000 inhabitants	41
20,000 - 50,000 inhabitants	96
< 20,000 inhabitants	1,431



Map 3. No. DWTPs, broken down by Autonomous Community.

1.4. STORAGE FACILITIES INVENTORY

The storage facilities inventory was obtained based on the same sources of information used in the case of water supply and sanitation networks: AEAS National Study (2018) for municipalities with more than 20,000 inhabitants and the EIEL for municipalities with less than 20,000 inhabitants. In this case, only storage facilities larger than 200 m3 were considered, since smaller ones have little relevance to the purpose of this study and, in addition, their use could result in an overestimation of the number of existing storage facilities and of the existing total capacity in the country.

Based on these information sources, a comprehensive database that provides information about the number of storage facilities and their main characteristics (capacity, expressed in m^3) is obtained, detailed according to regions and population strata. In this case, obtained data cover 48% of municipalities (with a population amounting to 77% of the national total). Again, in order to provide these data throughout the national territory, information from the database was extrapolated using the number of municipalities as raising factor.

Table 5 summarises the main results of the storage facilities inventory for national total, broken down by regions and population strata. Results detailed according to population strata and Autonomous Communities, jointly, can be found in Table A.4. within Appendix A.

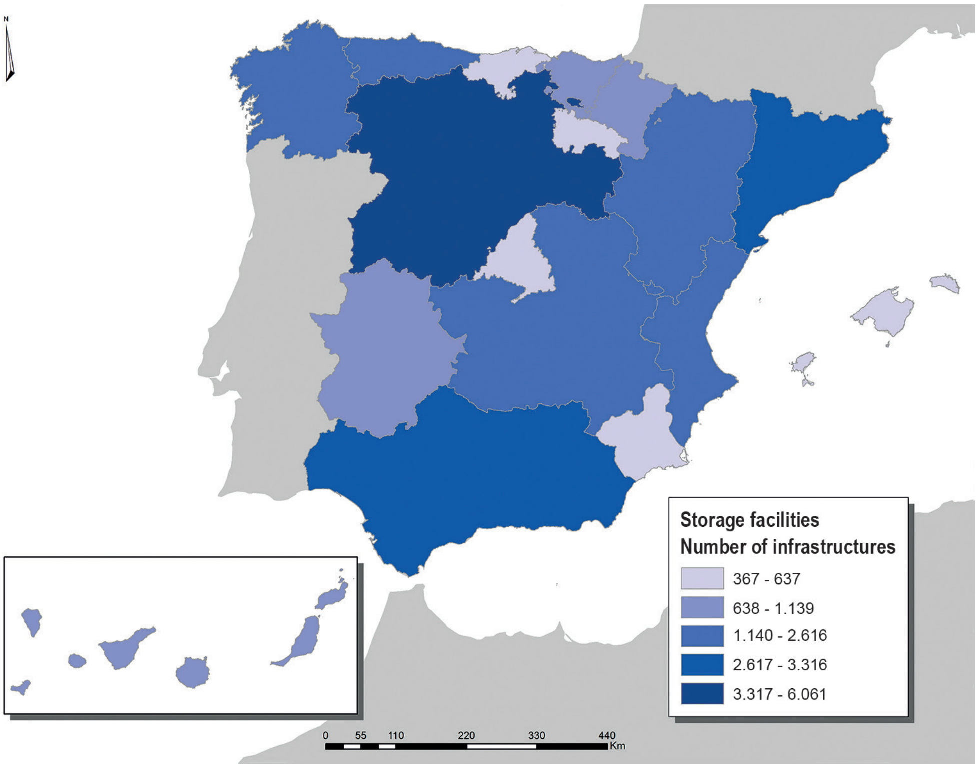
Table 5. Water storage facilities inventory, broken down by Autonomous Community and stratum

	No. STORAGE FACILITIES
Total	**29,305**
ACs:	
Andalusia	3,282
Aragon	2,368
Asturias	1,623
The Canary Islands	940
Cantabria	637
Castile and Leon	6,061
Castile-La Mancha	2,616
Catalonia	3,316
Valencian Community	2,136
Extremadura	1,139
Galicia	1,952
The Balearic Islands	411
Madrid	387
Navarre	829
The Basque Country	870
Region of Murcia	367
La Rioja	371
Strata:	
Metropolitan areas	957
> 100,000 inhabitants	952
50,000 - 100,000 inhabitants	553
20,000 - 50,000 inhabitants	1,524
10,000 - 20,000 inhabitants	2,445
5,000 - 10,000 inhabitants	2,755
1,000 - 5,000 inhabitants	7,754
< 1,000 inhabitants	12,365

The number of storage facilities in Spain amounts to 29,305, with a greater number in those regions with more municipalities, similarly to the case of DWTPs. Thus, in Table 5 and Map 4, it is apparent that Castile-Leon, Catalonia and Andalusia are the Autonomous Communities with the greatest number of storage facilities (with 20.68%, 11.31% and 11.20% of the national total, respectively). Conversely, Murcia, La Rioja, Madrid and Cantabria present the least number of storage facilities, and none of them exceeds 1.5% of the national total.

Results broken down by population strata, which can be found in Table 5, show, again, how the number of storage facilities is closely related to the number of municipalities within each stratum. Therefore, similarly to the case of DWTPs, most storage facilities (42.19% of the total) are located in municipalities with less than 1,000 inhabitants (accounting for more than half of

Spanish municipalities). This percentage decreases as larger population strata are considered, until metropolitan areas are reached, where, despite amounting to 29.39% of the Spanish population, they only account for 3.26% of the total number of storage facilities.



Map 4. No. water storage facilities, broken down by Autonomous Community.

1.5. STORMWATER TANKS INVENTORY

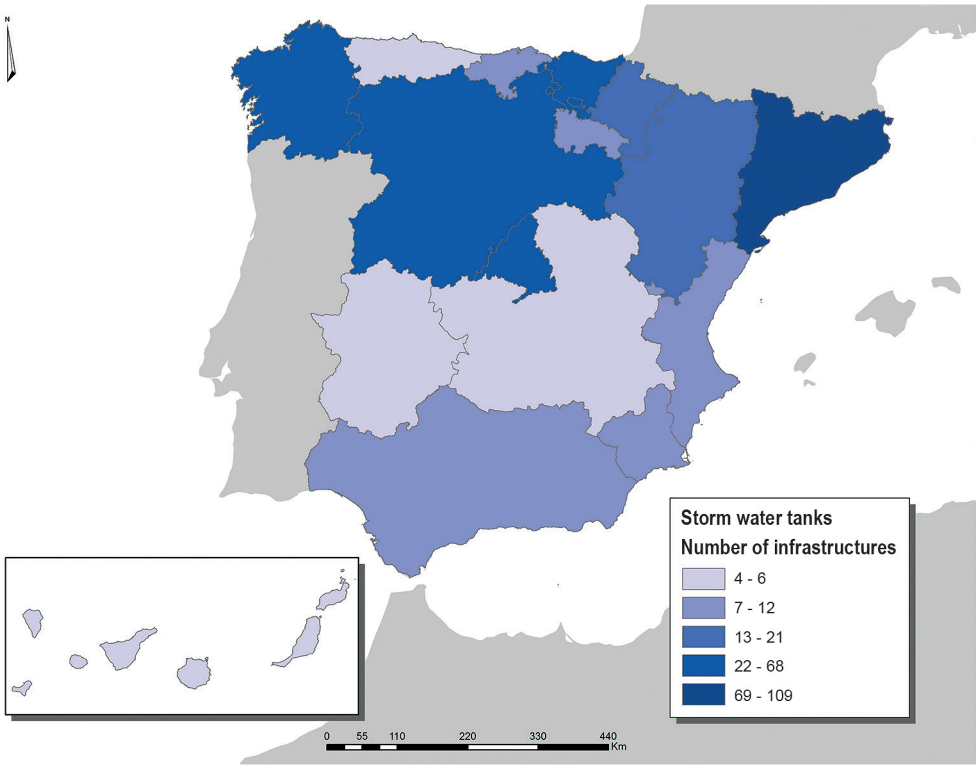
Regarding special sanitation infrastructures, the inventory of storm water tanks was obtained from information provided in this regard by AEAS National Study (2018), which reports the number of storm water tanks and their main characteristic (capacity, expressed in m^3), broken down by region and population strata.

However, statistics on water supply and sanitation by the National Institute of Statistics (INE) (2018) also provide information on the number of storm water tanks, broken down by Autonomous Community. Therefore, regarding those Autonomous Communities where data provided by the National Institute of Statistics (INE) (2018) is higher than that offered by AEAS (2018), the discrepancy in the number of deposits between these two sources of information was added to the inventory, assuming, in this case, that these storage facilities have a capacity equal to the storage facility average capacity in Spain, based on information obtained from data by AEAS (2018). Since information provided by the National Institute of Statistics (INE) (2018) is information concerning the whole national territory, no extrapolation was appropriate in this case.

Results of the inventory of storm water tanks, for Spain as a whole and broken down by Autonomous Communities, are shown in Table 6. In this case, detailed information according to stratum of population is not offered, since data by the National Institute of Statistics (INE) (2018) did not provide such a breakdown.

Table 6. Stormwater tanks inventory, broken down by Autonomous Community

	No. STORMWATER TANKS
Total	**456**
ACs:	
Andalusia	9
Aragon	17
Asturias	4
The Canary Islands	5
Cantabria	10
Castile and Leon	62
Castile-La Mancha	6
Catalonia	109
Valencian Community	12
Extremadura	5
Galicia	62
The Balearic Islands	0
Madrid	68
Navarre	21
The Basque Country	46
Region of Murcia	12
La Rioja	8



Map 5. No. stormwater tanks, broken down by Autonomous Community.

In total, there are 456 storm water tanks in Spain. Table 6 and Map 5 show the distribution of these infrastructures broken down by Autonomous Communities. It is apparent that Catalonia, Madrid, Galicia, Castile-Leon and the Basque Country are the Autonomous Communities with the greatest number of storm water tanks, while Asturias, the Canary Islands, Extremadura and Castile-La Mancha are those with the least presence of this type of infrastructure.

1.6. WASTE WATER TREATMENT PLANTS (WWTPS) INVENTORY

Data used for crafting the WWTPs inventory come from the Waterbase - Urban Waste Water Treatment Directive database (EEA, 2018). This database includes data reported by Spain to the European Commission in compliance with the WFD, which requires disclosure of waste water treatment plants in municipalities with over 2,000 population equivalent. This information enables the creation of a WWTPs inventory, broken down by Autonomous Communities, which includes the number of WWTPs and their main characteristic (its treatment capacity, and the population equivalent (p.e)).

In this case, it is not possible to compile information according to population strata, since this database does not provide such details. In addition, it should be noted that the resulting database does not provide information on the WWTPs that may be present in municipalities with less than 2,000 p.e. However, although this fact implies that the actual number of WWTPs in Spain may be slightly higher, no extrapolation was deemed appropriate in this case, since these WWTPs are considered to be of little relevance to the total investment in the urban water cycle in Spain.

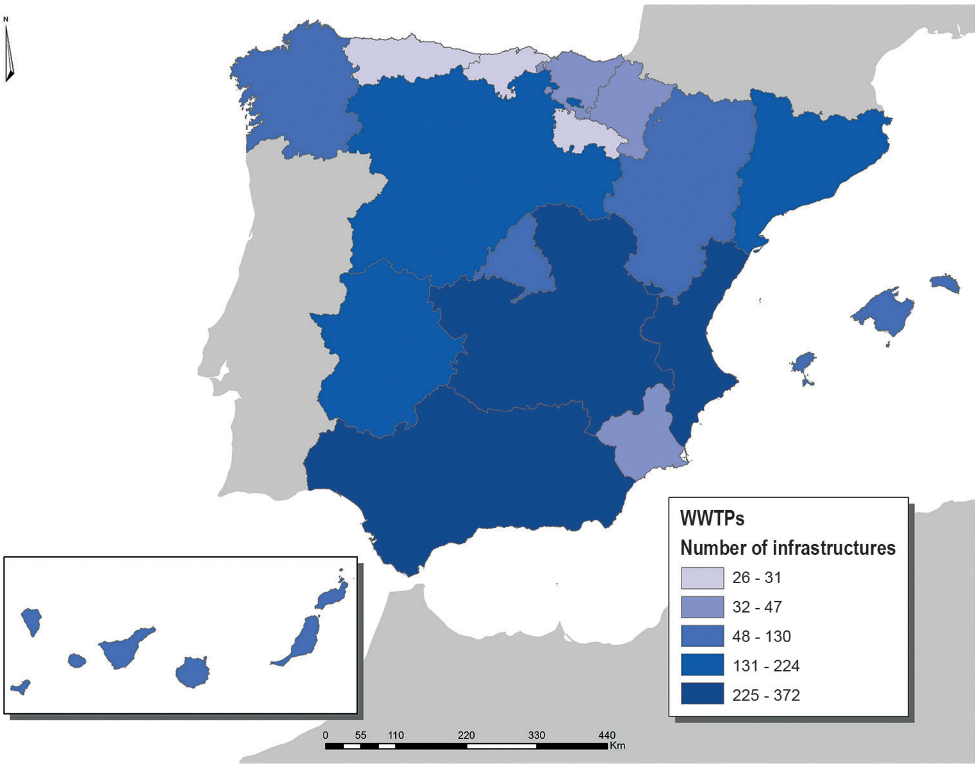
Results of the WWTPs inventory are presented in Table 7, which shows the number of WWTPs, according to the EEA database (2018) and their distribution broken down by Autonomous Communities. Additionally, this distribution according to Autonomous Community is provided in Map 6. It is important to stress that, since these data refer to WWTPs with more than 2,000 p.e., minor facilities[8], as well as those built in the time between the publication of this study and the year when the Spanish Government provided the date to the Agency, are not included in this inventory.

Table 7. WWTPs inventory, broken down by Autonomous Community

	No. WWTPs
Total	**2,232**
ACs:	
Andalusia	372
Aragon	94
Asturias	31
The Canary Islands	92
Cantabria	26
Castile and Leon	174
Castile-La Mancha	255
Catalonia	224
Valencian Community	276
Extremadura	159
Galicia	130
Barcelona	80
Madrid	154
Navarre	45
The Basque Country	45
Region of Murcia	47
La Rioja	28

[8] In the case of the Autonomous Community of Madrid, data on WWTPs with less than 2,000 p.e.are available, so these have been included in the inventory, in addition to those by the EEA.

There are 2,232 WWTPs in Spain, with Andalusia (372), Valencia (276), and Castile-La Mancha (255) being the regions with the greatest number of WWTPs. Conversely, the Autonomous Communities with the least number of WWTPs are Cantabria (26), La Rioja (28) and Asturias (31).



Map 6. No. WWTPs, broken down by Autonomous Community.

1.7. DRINKING WATER PUMPING STATIONS (DWPSS) AND WASTE WATER PUMPING STATIONS (WWPSS) INVENTORY

In order to achieve information on existing DWPSs and WWPSs in Spain, the "2018 Survey on the condition of water infrastructures in Spain" enquired respondents on this aspect. Based on data from this survey, information on the number of pumping stations and the main characteristics of these infrastructures (the installed power of pumps, expressed in kW) is available. However, it should be noted that the information on this pumping stations provided by this survey is limited, since, regarding DWPSs, it covers 1.5% of municipalities and 18.5% of the total population in Spain, and concerning WWPSs, it considers 1% of municipalities and 14% of the total population in Spain. For this reason, any kind of extrapolation to the total number of DWPSs and WWPSs in Spain was dismissed. However, the as-new replacement value of the cost resulting from deploying those DWPSs has been extrapolated, as subsequently detailed in Chapter 2.

CHAPTER 2.
INVENTORY VALUE

The aim of this second chapter is to economically define and assess the current value that would result from setting up at present all capital shown in the inventory presented in Chapter 1. Details on the specific methodology followed for estimating the costs associated with integrated water cycle networks and special infrastructures, as well as on the main results obtained, can be found below.

2.1. METHODOLOGY USED FOR NETWORKS

In order to obtain the current value that would result from deploying at present all water supply and sanitation networks shown in the inventory, it is necessary to have adequate knowledge of: (I) network length and composition (according to materials and diameters), obtained in Chapter 1 ; and (ii) the network linear metre price.

To address the latter issue, the methodological process consists of the following steps:

a. Municipalities clustering.

b. Defining the "standard" network work unit.

c. Obtaining network work unit prices.

d. Calculating the current value of the network, according to network materials and diameters.

The methodology used in each one of these stages is presented below.

a. Municipalities clustering.

Clustering, also known as group analysis, consists in grouping elements based on one or several of their characteristics, so that members of the same group (or cluster) are as similar as possible (Estivill-Castro, 2002). That is, in the case of municipalities, those municipalities that make up a cluster will bear the greatest resemblance, and also the slightest one to those municipalities within other clusters.

The objective of carrying out a clustering process regarding the municipalities in Spain is to classify them, not only in terms of population size (that is, the stratum of population), but also regarding network characteristics, in order to simplify the process of obtaining work units prices. Thus, by knowing those municipalities within the same cluster, it can be assumed that the prices of their networks are similar, so that the price of a certain number of municipalities can be applied to other municipalities in that cluster.

Analysis factors considered are as follows:

- Territorial factors: population size (inhabitants) and municipality area (expressed in km^2).
- Infrastructure variables: network length (km), network density, both in terms of population and area (km/inhabitant and km/km^2), and network material composition, considering the percentage represented by the six types of materials considered in this study (fibre cement (FC), ductile iron (DI), concrete (CO), PVC (PC), polyethylene (PE) and other materials (OT).

Clustering is performed using these variables, through k-means clustering. This technique makes it possible to group the set of elements in K groups, where each element belongs to the group with the closest average value (Estivill-Castro, 2002). In this case, five clusters (K=5) are defined, since the right balance between the explained variance and the number of groups is considered.

It should be noted that clustering is only applicable to municipalities with less than 20,000 inhabitants. Clustering is not performed for municipalities with more than 20,000 inhabitants, for two reasons: (i) microdata are not available for these municipalities, since data are taken from integrated information by AEAS (2018) rather than from Local Infrastructure and Equipment Survey (EIEL, in its Spanish acronym), and (ii) these amount to less than 10% of the national total, so that they can be grouped into the same type and considered to be within the same cluster (cluster 0).

Clustering results allow establishing a distribution of municipalities, broken down by cluster type for each Autonomous Community. The main charecteristics of those clusters obtained for the water supply network are as follows:

- Cluster 0: municipalities with more than 20,000 inhabitants.
- Cluster 1: municipalities with less than 20,000 inhabitants, with networks mainly made of FC.
- Cluster 2: municipalities with less than 20,000 inhabitants, with networks mainly made of PE.
- Cluster 3: municipalities with less than 20,000 inhabitants, with networks made of mixed materials.
- Cluster 4: municipalities with less than 20,000 inhabitants, with networks mainly made of CO.
- Cluster 5: municipalities with less than 20,000 inhabitants, with networks mainly made of PC.

And regarding sanitation networks:

- Cluster 0: municipalities with more than 20,000 inhabitants.
- Cluster 1: municipalities with less than 20,000 inhabitants, with networks mainly made of CO.
- Cluster 2: municipalities with less than 20,000 inhabitants, with networks mainly made of PE.
- Cluster 3: municipalities with less than 20,000 inhabitants, with networks mainly made of PC.
- Cluster 4: municipalities with less than 20,000 inhabitants, with networks mainly made of FC.
- Cluster 5: municipalities with less than 20,000 inhabitants, with networks mainly made of CO.

Table B.1. within Appendix B includes the distribution of municipalities according to cluster type, both for the water supply and sanitation networks. At this point, it should be mentioned that, at the national level, the most important water supply clusters are 1, 2 and 5, while the main sanitation cluster is 1.

b. Defining the "standard" network work unit.

Once clusters have been established, the next step is to obtain information through technical projects (mainly, tendering projects), to achieve the price pipeline linear metre. In total, projects included in Appendix C were analysed.

As a first approach, it was considered distributing the total price of the examined technical projects items among the installed meters of pipeline. However, after reviewing the obtained results, this technical criteria was ruled out due to the great disparity between the technical projects analysed; disparity in relation to those elements included in the items (especially mechanical components, such as valves), and disparity in relation to the total installed metres of pipeline (this means that, regarding small projects with reduced pipeline length, additional costs per linear metre of pipeline increase dramatically).

Therefore, new technical criteria were adopted: defining a "standard network" work unit, so that additional costs per linear metre of pipeline are based on elements of this "standard" work unit. Standardised criteria, obtained from municipal ordinances regulations, specifications of technical specifications, or service providers technical instructions, were used to obtain these elements (which are detailed in Appendix C). Official price catalogues were used to establish the price of these elements.

Elements and criteria adopted regarding the water supply network can be summarised as follows:

- Trench digging: The standard trench depends on the diameter (DN) of the tube to be installed, the type of trench, topography and terrain class, and the forecast of moving loads (for depth). Using a minimum depth of 1 m (from the pipeline crown) is recommended to protect pipelines against the effects of mechanical loads. Regarding width, in order to allow proper handling, the performance of pipeline couplings and filling compaction, a width exceeding pipeline diameter by 20 cm is recommended. Therefore, each linear meter of pipeline shall involve an associated digging equal to: 1 x (DN + 1) x (DN + 0.4). The price of the trench digging cubic meter depends on the type of terrain (soft, medium, hard, rock) and digging means available (manual, mechanical and blasting). In this case, the average price for digging in all terrain types using mechanical means is considered to be €15/m^3.

- Trench backfilling: If necessary for the terrain, due to its mechanical characteristics, it is recommended to include a concrete slab with a compressive strength of 150 kg/cm^2 and a thickness of 10 cm, followed by a 10 cm bed of river sand, which supports the pipelines, which are also filled with this same sand approximately 10 cm above the crown of the pipeline. If the concrete layer is not necessary, the base of the trench shall be levelled prior to backfilling. Therefore, each linear meter of pipeline shall involve an associated sand backfilling as follows[9]: 1 x 1 x (DN + 0.4). The price of backfilling m^3 depends on the source of this filling (if it comes from the digging itself, from material loans), its quality (suitable or selected soil), and whether or not it has been compacted. In this case, the average price for trench backfilling with selected soil from digging, including the levelling and compaction, is €6/m^3.

- Valves: Gate valves are recommended for diameters of 80 mm up to 200 mm. Butterfly valves are recommended for greater diameters. Valves are normally not included for diameters of under 80 mm. On the other hand, a distance of 100 m between valves is recommended. Therefore, each linear metre of pipeline shall involve an associated cost equal to 1/100 of the cost of a valve: The price of this valve (both gate and butterfly ones) depends on its diameter. In this case, the valve diameter is considered to be the same as the pipeline one.

[9] It is an approximation to the area of the trench section without pipelines.

- Irrigation valves[10]: Irrigation valve diameter shall be one that allows a flow rate of 5.7 l/s. In this case, a diameter of 40 mm is set. On the other hand, a distance of 50 m between these valves is recommended. Therefore, each linear metre of pipeline shall involve an associated cost equal to 1/50 of the cost of a washout. The price of washout depends on its model and diameter. In this case, the average price for completely installed standard washouts with a 40 mm diameter is €10.

- Hydrants: Hydrants must allow a flow rate of 16.67 l/s. In this case, a standard diameter of 100 mm is set. On the other hand, a distance of 200 m between hydrants is recommended. Therefore, each linear metre of pipeline shall involve an associated cost equal to 1/200 of the cost of a hydrant: The price of hydrants depends on the model (standpost hydrants, underground hydrant). In this case, the average price for 100 mm standpost hydrants is €350 per unit.

- Catchpits: Dimensions of catchpits depend on the elements within (valves, hydrants, flowmeters). The standard catchpit is considered to be 110 x 110 x 150 and made of bricks. Therefore, each linear metre of pipeline shall involve an associated cost equal to 1/100 of the cost of a catchpit, so the average price for catchpits containing valves is of €280 per unit.

- Supply connections: Supply connections to houses shall include, at least, one saddle on the distribution pipe, a fitting pipe (usually made of 25 mm low density polyethylene) and a gate valve on the outside of the facility. The number of supply connections per linear metre of pipeline depends on the number of serviced households. Considering an average network density, an average of 1 household per each 10 m of pipeline can be assumed. Therefore, each linear metre of pipeline shall involve an associated cost equal to 1/100 of the cost of a supply connection. The average supply connection price (including accessories such as flanges, fittings, gate valves, check valves, external manhole lid, etc.) is considered to be of €130 per unit.

- Accessories: Connecting elements and pipe accessories include: elbows, T or X fittings, filters and expansions or reductions, among others. Usually, accessories parts amount to 10-50% of the price of the pipeline. In this case, the average price is 15% of the price of the pipeline.

Conversely, elements and criteria adopted regarding the sanitation network can be summarised as follows:

- Trench digging: the same criteria as that followed for water supply networks are applied.

- Trench backfilling: the same criteria as that followed for water supply networks are applied.

- Valves: Its location within sanitation networks is exceptional and it is usually linked to other larger elements. In this case, the price of valves is not included, since these are considered to be an exceptional element.

- Gutter or sump: Placing sumps every 50 m is recommended, so that they collect rainwater corresponding to an area of 500 m^2. Therefore, each linear metre of pipeline shall involve an associated cost equal to 1/50 of the cost of a sump. The price of this sump depends on its size and the material used. A 200 x 200 cast iron drain (including frame and anchor) with a price of €35 per unit is considered to realise the price.

[10] The so called "bocas de riego" in Spanish, are valves suited for the extraction of water for irrigation purposes or for washing down streets, amongst other uses.

- Manholes: Manhole dimensions depend on the diameter of collectors. In that case, two standard manholes are taken into account: regarding DNs of less than 600 mm, manholes with a diameter of 1.2 m are used; while concerning greater DNs, manholes with a diameter of 1.5 m are used. In both cases, depth is 4 m. Furthermore, distance between manholes depends on collectors' diameter. In this case, two standard distances are considered: regarding DNs of less than 600 mm, separation is 50 m; concerning greater DNs, these are 150 m apart. Therefore, each linear metre of pipeline shall involve an associated cost equal to 1/50 or 1/150 of the cost of a washout, respectively. The price of the manhole depends on its dimensions and the material used. In this case, a 16 cm thick manhole made of pre-cast reinforced concrete pieces was considered. Its price (including perforations aimed at connecting pipes, rubber gaskets and additional resources) is €1,100 per unit for manholes with a diameter of 1.2 m and €1,500 per unit for wells with a diameter of 1.5 m.
- Catchpits: Catchpit dimensions depend on the elements within. In this case, the standard catchpit is considered to be 40 x 40 x 50 and made of bricks. Therefore, each linear metre of pipeline shall involve an associated cost equal to 1/100 of the cost of a catchpit. In this case, the average price for catchpits containing valves is of €80 per unit.
- Supply connections: the same criteria as that followed for water supply networks is applied.
- Accessories: Connecting elements and pipe accessories include: elbows, T or X fittings, filters and expansions or reductions, among others. Usually, accessories parts amount to 10-50% of the price of the pipeline. In this case, the average price is 10% of the price of the pipeline.

c. *Obtaining network work unit prices.*

Once the above criteria are established, the next step is to analyse various technical projects detailed in Appendix C, to calculate the price per linear meter of pipeline. Based on this pipeline material price, the prices of those additional elements that make up the standard work unit are obtained for each cluster: price of civil works (digging and trench), price of parts (electromechanical components and accessories) and total price (piping, civil works and parts).

However, since it was not possible to compile a project for each combination of material, diameter and cluster, the extrapolation of some prices was necessary. The criteria followed for this extrapolation of prices are as follows: if data from real projects are available, the price is the average price of the projects for each material, diameter and cluster; if a cluster has no associated project, the average prices of other clusters are applied; when all clusters lack associated project, the official catalogue prices are used (in this case, ratios between pipeline, civil works, parts and total price are defined taking into account those based on projects). The list of analysed catalogues is included in Appendix C.

Work unit prices, broken down by cluster, material and diameter type, are obtained based on the aforementioned information[11]. Prices achieved according to cluster are shown in Table D.1. within Appendix D. It is important to stress that, in order to obtain those prices, diameters are classified into three groups: small (P), medium (M) and large (G). Thresholds for these groups are detailed in Table 8.

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[11] The price of OT materials (other materials) was obtained, as the known materials average prices.

Table 8. Thresholds (expressed in millimetres) used for the classification of diameters into small, medium and large; broken down by material.

WATER SUPPLY			SANITATION		
MATERIAL	THRESHOLD 1	THRESHOLD 2	MATERIAL	THRESHOLD 1	THRESHOLD 2
FIBRE CEMENT	90	160	FIBRE CEMENT	400	800
POLYETHYLENE	90	160	POLYETHYLENE	400	800
PVC	90	160	PVC	250	400
DUCTILE IRON	200	350	DUCTILE IRON	250	400
CONCRETE	400	1,000	CONCRETE	800	1,200

Once prices of the linear meter of pipeline according to cluster are obtained, the last step is to achieve the price by Autonomous Community and population strata. For strata with more than 20,000 inhabitants, the prices corresponding to the linear meter of cluster pipeline are adopted. For strata of population with less than 20,000 inhabitants, prices are calculated as a weighted average of cluster 1-5 prices, and weighting is performed according to the length of the network in each cluster. The list of final prices broken down by Autonomous Community, stratum, material and diameter is included in Table D2 within Appendix D.

d. Economical assessment of the network.

Once the composition of water supply and sanitation networks is known, that is, network length according to each type of material and diameter, lengths are multiplied by the price of the linear metre of pipeline. This assessment of water supply and sanitation networks is performed for each Autonomous Community separately, and the value of the network nationwide is obtained as the sum of the value of all Autonomous Communities networks.

In the case of water conveyance networks, information on the value of this network comes entirely from AEAS National Study (2018), which provides this information related to the national total, and is broken down by population strata. In order to also achieve this information by Autonomous Communities, the value of the network of each stratum of population was distributed among the different Autonomous Communities according to the percentage represented by the stratum in relation to the Autonomous Community total for the remaining inventory.

2.2. METHODOLOGY USED FOR SPECIAL INFRASTRUCTURES

In order to achieve the current value that would result from deploying at present all special infrastructures listed in the inventory, a methodological process in 3 stages was used. The first step consists in researching information from technical projects (mainly tendering ones), to obtain infrastructure data and its main characteristics and cost. In total, 166 projects were consulted, as detailed in Appendix E. The second stage is based on obtaining estimates (regressions) that link each infrastructure characteristic with its cost, so that an econometric ratio between these two factors can be established. And finally, the third stage is aimed at applying this econometric regression to the inventory of special infrastructures, which was obtained in Chapter 1. This three-stage process is carried out for each special infrastructures considered, as detailed below.

Drinking water treatment plants (DWTPs)

Regarding DWTPs, a ratio is established between DWTPs design flow (expressed in m^3, per hour) and costs (in €). The estimate obtained from this regression is defined as[12]:

$$\ln (Cost) = 10.2361 + 0.7552 \ln (flow\ rate) \quad (1)$$

It should be noted that the regression between costs and main characteristics is estimated using Napierian logarithm, to avoid being dependent on the measuring unit, that is, relativise the comparison between different size infrastructures. This also facilitates the interpretation of estimated coefficients. In the case of the equation (1), the ratio between both factors is interpreted considering that an increase amounting to 1% regarding DWTPs design flow increases its cost by 0.7552%. This ratio between these two factors is graphically presented in Figure 3.

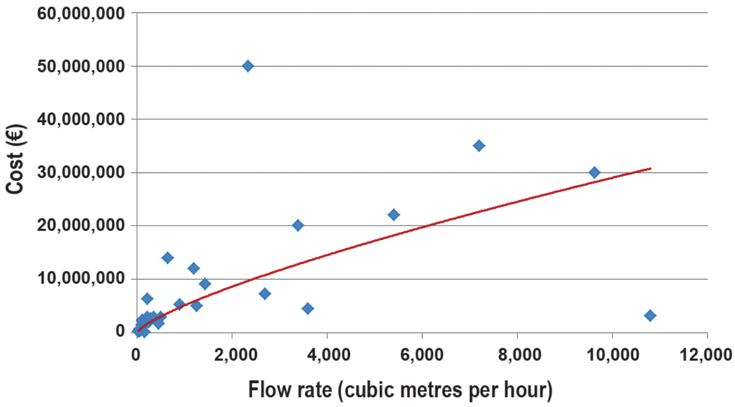


Figure 3. Ratio between DWTPs flow and costs.

The current value that would result from deploying at present all existing DWTPs in Spain is obtained by using the aforementioned ratio as follows. Regarding those DWTPs for which flow related to each infrastructure is available thanks to AEAS information (2018), the regression obtained in formula (1) is applied to each infrastructure and DWTPs costs are calculated[13]. Concerning the remaining, in relation to each stratum of population within each Autonomous Community, unknown DWTPs are obtained by subtracting the number of DWTPs known thanks to AEAS (2018) from the number of DWTPs based on information of the SINAC. In the case of these unknown DWTPs (data on the flow of each infrastructure is not available), the average cost of the DWTPs within that stratum of population in Spain (obtained by applying the regression calculated in formula (1) to the average DWTPs flow within that stratum of population) is applied. This makes it possible to calculate the total cost of the facility, by adding the cost of known and unknown DWTPs.

[12] $R^2 = 0.6587$; *Adjusted* $R^2 = 0.6465$; $F(1.28) = 54.04$ (p-value = 0.0000).

[13] By applying the exponential function to the Napierian logarithm of the cost.

Storage facilities

Regarding storage facilities, it is possible to establish a ratio between the storage facility capacity (expressed in m³) and its cost (in €). The regression describing the ratios between these two factors is as follows[14]:

$$\ln (Cost) = 7.8036 + 0.7306 \ln (Capacity) \quad (2)$$

In this case, the regression obtained suggests an increase of 1% in storage facility capacity results in costs increasing by 0.7306%. This ratio is also graphically shown in Figure 4.

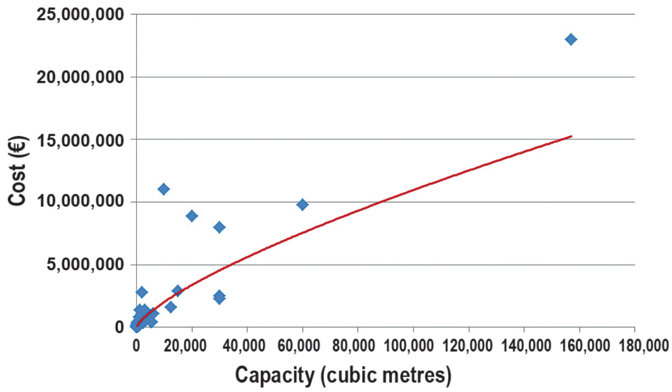


Figure 4. Ratio between storage facility capacity and cost.

Once the ratio between storage facility capacity and cost is obtained, this ratio is applied to the inventory as follows. Regarding storage facilities known based on AEAS information (2018), regression (2) is applied to each infrastructure and the cost of such storage facilities is calculated[15]. Subsequently, concerning each stratum within each Autonomous Community, unknown storage facilities are obtained as the difference between those storage facilities obtained after extrapolating AEAS deposits (2018), as described in Section 1.4, and deposits comprehensively known based on that source of information. The average cost of the storage facilities of that stratum within the Autonomous Community, which results from applying regression (2) to the average capacity of that stratum within that Autonomous Community, is applied to those unknown storage facilities (for which capacity data is not available)[16]. If required data in relation to specific strata of any Autonomous Community is not available, the national stratum data is used. Finally, the total cost of storage facilities is obtained by adding the number of known and unknown storage facilities.

Storm water tanks

Concerning storm tanks, similarly to all other infrastructures, the ratio between storm water tanks capacity (expressed in m³) and costs (in €) is obtained. The result of applying the regression to these two factors is as follows[17]:

[14] R^2 = 0.7823; Adjusted R^2 = 0.7774; F (1.44) = 158.13 (p-value = 0.0000).

[15] By applying the exponential function to the Napierian logarithm of the cost.

[16] It should be noted that, unlike the case of DWPPs, regarding storage facilities, it was possible to use the average data from each stratum within each Autonomous Community, rather than the average data of the stratum within the national total. This was possible thanks to the high volume of data covered by AEAS (2018) with respect to storage facilities; which is not the case for DWPPs.

[17] R^2 = 0.8216; Adjusted R^2 = 0.8155 ; F (1.29) = 133.58 (p-value = 0.0000) .

$$\ln (Cost) = 5.3969 + 1.0447 \ln (Capacity) \quad (3)$$

Similarly, this ratio between these two factors is graphically presented in Figure 5.

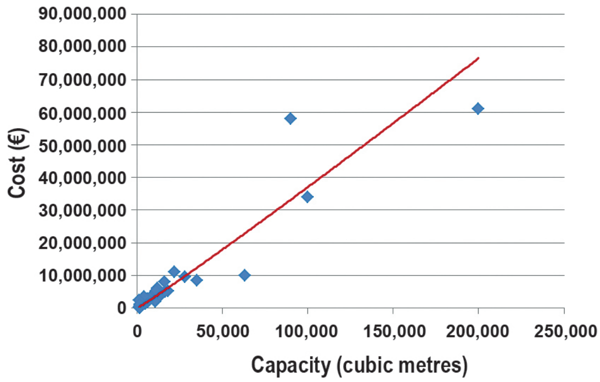


Figure 5. Ratio between storm water tanks capacity and cost.

Finally, obtaining the total cost of investment in storm water tanks is performed in two stages. Firstly, regression (3) is applied to storm water tanks known thanks to AEAS information (2018), to obtain the cost of such infrastructures[18]. Secondly, concerning the storm tanks that were obtained from the National Institute on Statistics (INE) (2018) and incorporated into the inventory (of which capacity data is not available), the average cost of storm water tanks in Spain is applied (which depends on storm water tans average capacity)[19].

Thus, adding both costs, the economic assessment of storm water tanks for the national total and Autonomous Communities is obtained, since, as expressed above, data by the National Institute of Statistics (INE) (2018) were not broken down by population strata. In order to achieve this data broken down by strata, the following procedure was followed: regarding each Autonomous Community, storm water tanks from the National Institute of Statistics (INE) (2018) were distributed by population strata according to the distribution of storm water tanks based on AEAS data (2018), which did provide this breakdown.

Wastewater treatment plants (WWTPs)

In the case of WWTPs, again, their main characteristic, which is their treatment capacity (equivalent of inhabitants), can be linked with their cost (in €). In this case, the projects consulted (and detailed in Appendix E) were divided into WWTPs, servicing large metropolitan areas, provincial capitals and other large cities (with a capacity equivalent of 50,000 inhabitants and over), and smaller WWTPs (with a capacity of up to 50,000 inhabitants). The reason behind performing this division is the fact that a better statistical regression is achieved between these two infrastructure groups, due to physical characteristics and the specific waste water treatment procedures specifically associated, generally speaking, to these two groups.

[18] By applying the exponential function to the Napierian logarithm of the cost.

[19] In the case of storm tanks, it was not possible to use the average data of each Autonomous Community, since there was a lack of sufficient data to perform statistical inference. Using the average data by stratum of population was also not possible, since the stratum of population of municipalities housing storm water tanks obtained from the National Institute of Statistics (INE) (2018) is not available.

In the case of large WWTPs, the regression that links their capacity with costs is as follows[20]:

$$\ln (Cost) = 8.9157 + 0.6596 \ln (Capacity) \qquad (4)$$

Concerning smaller WWTPs, the ratio between both factors is as follows[21]:

$$\ln (Cost) = 8.1814 + 0.7596 \ln (Capacity) \qquad (5)$$

Therefore, in the case of WWTPs, an increase of 1% in treatment capacity results in an increase in processing costs by 0.6596% for larger WWTPs and by 0.7596% for minor WWTPs. The ratios of these two factors are shown in Figures 6 & 7.

Finally, regressions (4) and (5) are applied to the large WWTPs and smaller WWTPs within the inventory, respectively. It should be recalled that, as detailed in Section 1.6, no extrapolation was made in the case of WWTPs.

Thus, the economical assessment of these infrastructures is obtained, for Spain as a whole and according to Autonomous Community, by adding the cost of both types of WWTPs, since the EEA (2018) does not provide a breakdown by population strata. In order to obtain this breakdown, the value of the WWTPs within each Autonomous Community has been distributed among the various population strata, classifying WWTPs according to their population equivalent.

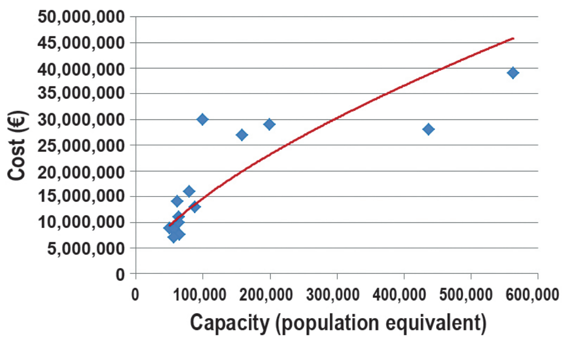


Figure 6. Ratio between large WWTPs capacity and cost.

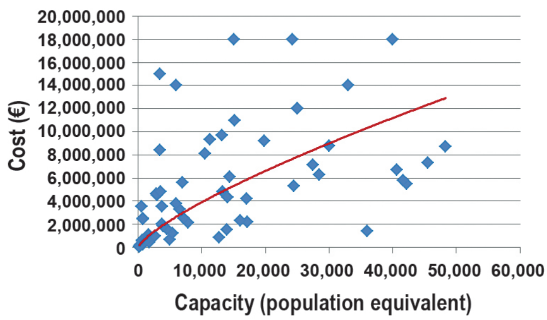


Figure 7. Ratio between smaller WWTPs capacity and cost.

[20] R^2 = 0.7407; Adjusted R^2 = 0.7207; F (1.13) = 37.13 (p-value = 0.0000).

[21] R^2 = 0.6449; Adjusted R^2 = 0.6394 ; F (1.65) = 118.03 (p-value = 0.0000).

Drinking water pumping stations (DWPSs) and Waste water pumping stations (WWPSs)

In order to calculate the cost of DWPSs and WWPSs, pumping stations technical projects have been analysed[22] (detailed in Appendix E), obtaining information for each infrastructure regarding the installed capacity of their pumps (expressed in kW) and their cost (in €).

Taking into account this information, an econometric regression is made, which tries to estimate the ratio between these two factors, obtaining the following one[23]:

$$\ln (Cost) = 9.5449 + 0.5408 \ln (Capacity) \quad (6)$$

It is found that an increase of 1% in the installed capacity of a pumping station increases its cost by 0.5408%. This ratio between these two factors is graphically presented in Figure 8.

The last step is to apply the regression obtained in formula (6) to the DWPSs and WWPSs inventories, respectively, thus calculating the cost of these types of infrastructure[24]. However, since the inventory of pumping stations does not cover 100% of the Spanish population, as detailed in Section 1.7, the cost was extrapolated according to the population, to obtain the cost of these infrastructures for the national total. In addition, the total cost obtained for DWPSs and WWPSs, for Spain as a whole, was distributed among the different Autonomous Communities and population strata, according to the corresponding population.

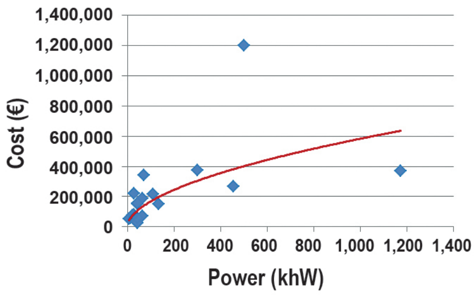


Figure 8. Ratio between pumping stations installed power and cost.

2.3. RESULTS

Results concerning the current value of the cost that would result from deploying all special infrastructures and networks within the inventory are shown in Tables 9 and 10.

Table 9 shows the results for networks, for the national total and broken down by region and strata of population. The conveyance network has a current value of €5,138 million. Regarding water supply and sanitation networks, these are valued at €36,059 million and €128,917 million, respectively. This significant difference in the value of water supply and sanitation networks is due to their different diameters. Sanitation networks typically use larger diameters (sometimes 5 times larger than water supply ones), since the water flow conveyed is greater (and because, generally,

[22] In the case of pumping stations, it was difficult to obtain enough differentiated information on DWPSs and WWPSs to perform statistical inference. Therefore, the regression to be applied to DWPSs and WWPSs include both types of pumping stations.

[23] R^2 = 0.5396; Adjusted R^2 = 0.5125; F (1,17) = 19.93 (p-value = 0.0003) .

[24] By applying the exponential function to the Napierian logarithm of the cost.

the sanitation network is oversized, so as to also include the rainwater network). This increases the cost of both pipeline materials and associated civil works. Thus, the value of the sanitation network is nearly 4 times the value of the water supply one, although the former is shorter, as shown by the data provided in Chapter 1.

Table 9. Current value of each network that make up the inventory (expressed in € millions), broken down by Autonomous Community and population strata

	WATER CONVEYANCE NETWORK	WATER SUPPY NETWORK	SANITATION NETWORK
Total	**5,138**	**36,059**	**128,917**
ACs:			
Andalusia	779	5,750	21,692
Aragon	219	779	3,588
Asturias	107	983	2,393
The Canary Islands	146	1,931	4,203
Cantabria	66	372	1,399
Castile and Leon	671	2,427	10,776
Castile-La Mancha	420	1,970	7,754
Catalonia	624	4,114	16,737
Valencian Community	550	4,004	16,389
Extremadura	202	904	4,135
Galicia	413	2,637	9,705
The Balearic Islands	68	568	1,512
Madrid	364	4,966	13,721
Navarre	108	850	2,442
The Basque Country	235	2,114	6,200
Region of Murcia	129	1,498	5,476
La Rioja	37	190	796
Strata:			
Metropolitan areas	766	9,644	29,340
> 100,000 inhabitants	440	5,596	24,837
50,000 - 100,000 inhabitants	281	3,756	15,549
20,000 - 50,000 inhabitants	341	5,368	15,895
< 20,000 inhabitants	3,311	11,695	43,296

In any case, a similar distribution of the current value broken down by Autonomous Community is observed for these different networks. Andalusia, Valencia, Catalonia and Madrid are those with the greatest current value percentage of the Spanish total network. Conversely, La Rioja, Cantabria, and the Balearic Islands are those with the least percentage. Broken down by population strata, most of the networks value is concentrated in municipalities with less than 20,000 inhabitants (amounting to 64% of the water conveyance network cost, 32% of the water supply network and 34% of the sanitation network) and in metropolitan areas (accounting for 15% of the cost of the water conveyance network, 27% of the water supply network and 23% of sanitation network); these are the strata of population with the greatest network length, since they gather a large number of people in Spain.

Table 10 shows the results for special infrastructures, for the national total, broken down by regions and population strata.

Table 10. Current value of each special infrastructures that make up the inventory (expressed in € millions), broken down by Autonomous Community and population strata

	DWTPs	STORAGE FACILITIES	STORM WATER TANKS	WWTPs	DWPSs	WWPSs
Total	**7,454**	**12,188**	**1,413**	**14,466**	**686**	**1,170**
ACs:						
Andalusia	1,151	1,633	27	2,384	124	212
Aragon	477	908	3	465	19	33
Asturias	163	478	11	272	15	26
The Canary Islands	352	698	3	519	31	53
Cantabria	89	186	9	218	9	15
Castile and Leon	2,110	1,685	155	894	36	62
Castile-La Mancha	224	725	12	905	30	51
Catalonia	894	1,406	364	2,005	111	190
Valencian Community	438	1,161	67	1,841	73	125
Extremadura	99	337	18	556	16	27
Galicia	359	659	40	778	40	69
The Balearic Islands	155	170	-	461	16	28
Madrid	404	756	513	1,575	96	163
Navarre	50	319	71	282	9	16
The Basque Country	281	782	77	487	32	55
Region of Murcia	151	154	16	657	22	37
La Rioja	57	131	29	165	5	8
Strata:						
Metropolitan areas	885	1,921	562	2,472	206	351
> 100,000 inhabitants	439	1,071	265	3,397	130	222
50,000 - 100,000 inhabitants	199	588	493	1,536	69	118
20,000 - 50,000 inhabitants	241	989	59	2,441	86	146
< 20,000 inhabitants	5,690	7,619	34	4,620	196	333

Regarding DWTPs, the 1,640 ones existing in Spain (according to the information within Table 4) have a current value of €7,454 million. Broken down by Autonomous Communities, the largest number of DWTPs (due to a larger number of these infrastructures) is concentrated in those Autonomous Communities with a greater number of municipalities, such as Castile-Leon, Andalusia and Catalonia (amounting to 28.31%, 15.44% and 12.00% of the total number of DWTPs in Spain, respectively). By contrast, the Autonomous Communities with a lesser number of DWTPs are Navarre, La Rioja and Madrid, since none of them exceeds 1.2% of the national total number of municipalities. Table 10 also shows that most of the current value of DWTPs (as was the case with the number of infrastructures) is located in municipalities with less than 20,000 inhabitants (accounting for 76.33% of the total current value). However, this ratio between the number of DWTPs and their current value is similarly reflected within other strata. The most extreme case is that of metropolitan areas, where only 1.10% of DWTPs are located (according to the information inTable 4), despite accounting for 11.88% of the total current value. This has to with the fact that, while it is possible that metropolitan areas do not require a large number of DWTPs, these must have a large capacity, in order to service the population concentrated therein, which results in a considerable increase of their overall cost.

Regarding storage facilities, the 29,305 ones existing in Spain (listed in Table 5) have a current value of €12,188 million. Generally, it appears that Autonomous Communities housing a greater number of storage facilities, amount to a greater percentage of these infrastructures total current value. However, there are some exceptions, such as Madrid, where only 1.33% of storage facilities in Spain are located, despite the fact these account for 6.20% of the total current value. This is because, as previously noted, all existing storage facilities within Madrid metropolitan area shall have a high capacity to service the population that lives there, which substantially increases their cost. In fact, this situation is also observed for metropolitan areas, in general, where 3.04% of storage facilities are located, which account for 15.76% of the total current value. Excluding the above case, in general, current value is higher in those population strata with more associated storage facilities. Thus, the stratum of the population corresponding to less than 20,000 inhabitants (which is the one with a larger number of municipalities and, therefore, storage facilities) is the one amounting to the greatest percentage of the total current value (62.51%).

Looking into the existing 456 storm water tanks information detailed in Table 6), these have a current value of €1,413 million. As regards the distribution according to Autonomous Communities, again, while in many cases more infrastructures often involve higher costs, there are some exceptions. Thus, some Autonomous Communities show a greater percentage of the number of storm water tanks than of the current value, such as Galicia (where its 62 storm water tanks amount to 13.60% of the national total, but only 2.83% of the total current value). However, in other Autonomous Communities, the opposite is true, as in Madrid (where its 68 storm water tanks account for only 14.91% of the national total, but 36.31% of the total current value in Spain). According to strata of population, those with a greater number of people are the ones that accumulate the highest percentage of the value of these infrastructures, with those municipalities with less than 50,000 inhabitants amounting to only 6.6% of the total value.

The 2,232 WWTPs existing in Spain (see Table 7) have a current value of €14,466 million. With regard to the current value represented by each Autonomous Community in relation to the national total, Andalusia (16.48%), Catalonia (13.86%), Valencia (12.73%) and Madrid (10.89%) are the Autonomous Communities with the greatest percentage, while La Rioja, Cantabria, Asturias and Navarre are those with the lowest one (none of which accounts for more than 2% of the national total). It should be noted that the result of the inventory of WWTPs in Spain and their size relative to the project flow and the polulation equivalent, are provided by EuroStat based on information by the Ministry for the Ecological Transition, so that the inventory was obtained without implementing extrapolation statistical techniques. Results according to strata show that municipalities with less than 20,000 inhabitants (stratum that gathers the largest part of the Spanish population) accumulate the highest percentage of the value of these infrastructures (32%), followed by great dispersion among the remaining strata.

Regarding pumping stations, the cost that would result from deploying at present all DWPSs existing in Spain is €686 million, while WWPSs cost €1,170 million. Andalusia, Catalonia and Madrid are the Autonomous Communities amounting to the greatest percentage of pumping stations current value of the national total (18.08%, 16.22% and 13.94% of the total, respectively). By contrast, La Rioja, Cantabria and Navarre are the Autonomous Communities with the lowest associated investment, all of them accounting for less than 1.5% of the total. According to population strata, metropolitan areas and municipalities with less than 20,000 inhabitants are the ones with the highest value (30% and 28%, respectively).

Once results regarding the current value of each one of the networks and infrastructures are presented, Table 11 reflects the as-new replacement value of the whole inventory. These results are broken down by urban water cycle stage (water supply and sanitation) and type (networks and infrastructures). Results are presented broken down by regions and population strata.

Thus, as shown in Table 11, the set of networks and special infrastructures within the inventory has a as-new replacement value of €207.5 billion, for Spain as a whole. Thereof, 70% corresponds to the sanitation and 30% to water supply. Similarly, it is verified that 82% of the total current value is linked to networks and 18% to special infrastructures.

Table 11. As-new replacement value of all inventory (expressed in € millions), broken down by Autonomous Community and population strata

	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Total	**207,492**	**61,525**	**145,967**	**170,114**	**37,378**
ACs:					
Andalusia	33,752	9,438	24,315	28,221	5,531
Aragon	6,491	2,402	4,089	4,586	1,905
Asturias	4,448	1,746	2,702	3,483	965
The Canary Islands	7,937	3,158	4,779	6,281	1,656
Cantabria	2,363	722	1,640	1,837	525
Castile and Leon	18,816	6,930	11,886	13,874	4,942
Castile-La Mancha	12,092	3,369	8,722	10,144	1,948
Catalonia	26,446	7,150	19,296	21,475	4,970
Valencian Community	24,648	6,226	18,422	20,943	3,705
Extremadura	6,295	1,559	4,736	5,240	1,055
Galicia	14,700	4,108	10,592	12,755	1,944
The Balearic Islands	2,979	978	2,001	2,148	831
Madrid	22,558	6,585	15,973	19,051	3,507
Navarre	4,149	1,337	2,812	3,401	748
The Basque Country	10,264	3,445	6,819	8,549	1,715
Region of Murcia	8,139	1,954	6,185	7,103	1,036
La Rioja	1,416	419	998	1,022	394
Strata:					
Metropolitan areas	46,146	13,422	32,724	39,750	6,396
> 100,000 inhabitants	36,398	7,676	28,722	30,873	5,525
50,000 - 100,000 inhabitants	22,590	4,893	17,697	19,587	3,003
20,000 - 50,000 inhabitants	25,565	7,024	18,541	21,603	3,962
< 20,000 inhabitants	76,793	28,510	48,283	58,302	18,491

According to Autonomous Communities, those amounting to the highest current value compared to the national total are Andalusia (16.27%), Catalonia (12.75%), Valencia (11.88%) and the Autonomous Community of Madrid (10.87%). This pattern is observed for the two urban water cycle stages, as well as for networks and infrastructures. By contrast, the Autonomous Communities with a lesser current value are La Rioja, Cantabria, Navarre and Asturias, since none of them exceeds 2% of the national total.

With regard to the results according to population strata, municipalities with less than 20,000 inhabitants accumulate 37.01% of the total current value, followed by metropolitan areas (22.24%); these are strata with a larger number of people and municipalities in Spain and, therefore, more networks and infrastructures, as stated in Chapter 1.

In addition, in order to provide further information, Table 12 shows the results of the inventory current value for each stratum of population within each Autonomous Community. Furthermore, besides providing the total current value of the networks and infrastructures inventory for the different Autonomous Communities and population strata, it is also interesting to know the value of the inventory for each municipality. To this end, Table A.5 within Appendix A shows the current value of the inventory for a “standard municipality” (or average municipality) for each stratum of the population within each Autonomous Community. Thus, Table A.5 within Appendix A is a very useful tool for municipalities, since by locating a particular municipality in the corresponding stratum of population and Autonomous Community, an estimation of the current value of their urban water cycle networks and infrastructures, based on the “standard municipality” data for that stratum in that Autonomous Community can be obtained.

Table 12. Current value of the inventory (expressed in € millions). Results are broken down according to Autonomous Community and stratum (subsets of population)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Andalusia	> 100,000 inhabitants	12,645	3,203	9,442	11,073	1,572
Andalusia	50,000 - 100,000 inhabitants	5,662	1,212	4,450	5,136	526
Andalusia	20,000 - 50,000 inhabitants	4,536	1,250	3,287	3,756	780
Andalusia	< 20,000 inhabitants	10,909	3,774	7,136	8,256	2,653
Aragon	> 100,000 inhabitants	1,602	493	1,110	1,358	245
Aragon	50,000 - 100,000 inhabitants	306	47	259	217	89
Aragon	20,000 - 50,000 inhabitants	339	88	251	199	140
Aragon	< 20,000 inhabitants	4,243	1,775	2,468	2,812	1,431
Asturias	> 100,000 inhabitants	1,901	443	1,459	1,651	250
Asturias	50,000 - 100,000 inhabitants	403	132	271	336	67
Asturias	20,000 - 50,000 inhabitants	536	166	370	435	100
Asturias	< 20,000 inhabitants	1,609	1,007	602	1,061	548

(Continuation TABLE 12)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
The Canary Islands	> 100,000 inhabitants	3,631	949	2,682	3,235	396
The Canary Islands	50,000 - 100,000 inhabitants	1,040	311	729	872	168
The Canary Islands	20,000 - 50,000 inhabitants	1,660	869	791	1,325	336
The Canary Islands	< 20,000 inhabitants	1,606	1,028	577	848	757
Cantabria	> 100,000 inhabitants	662	119	543	518	144
Cantabria	50,000 - 100,000 inhabitants	207	49	158	168	40
Cantabria	20,000 - 50,000 inhabitants	286	64	222	238	47
Cantabria	< 20,000 inhabitants	1,207	490	717	913	294
Castile and Leon	> 100,000 inhabitants	2,833	590	2,243	2,312	521
Castile and Leon	50,000 - 100,000 inhabitants	1,619	409	1,210	1,408	211
Castile and Leon	20,000 - 50,000 inhabitants	590	125	465	461	129
Castile and Leon	< 20,000 inhabitants	13,775	5,805	7,969	9,693	4,081
Castile-La Mancha	> 100,000 inhabitants	696	132	564	548	148
Castile-La Mancha	50,000 - 100,000 inhabitants	1,343	322	1,021	1,160	183
Castile-La Mancha	20,000 - 50,000 inhabitants	1,273	305	968	1,046	228
Castile-La Mancha	< 20,000 inhabitants	8,779	2,610	6,169	7,390	1,389
Catalonia	> 100,000 inhabitants	9,065	1,995	7,070	7,577	1,489
Catalonia	50,000 - 100,000 inhabitants	3,212	543	2,669	2,519	694
Catalonia	20,000 - 50,000 inhabitants	5,359	1,188	4,171	4,777	582
Catalonia	< 20,000 inhabitants	8,809	3,424	5,385	6,603	2,206
Valencian Community	> 100,000 inhabitants	10,337	2,533	7,804	8,898	1,439
Valencian Community	50,000 - 100,000 inhabitants	3,304	543	2,760	2,859	445
Valencian Community	20,000 - 50,000 inhabitants	4,232	1,128	3,104	3,774	458
Valencian Community	< 20,000 inhabitants	6,775	2,021	4,754	5,412	1,363

(Continuation TABLE 12)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Extremadura	> 100,000 inhabitants	618	106	512	556	62
Extremadura	50,000 - 100,000 inhabitants	816	251	565	718	98
Extremadura	20,000 - 50,000 inhabitants	604	143	460	521	83
Extremadura	< 20,000 inhabitants	4,257	1,058	3,199	3,444	813
Galicia	> 100,000 inhabitants	2,985	562	2,423	2,598	387
Galicia	50,000 - 100,000 inhabitants	2,334	577	1,757	2,239	94
Galicia	20,000 - 50,000 inhabitants	2,142	488	1,654	1,893	250
Galicia	< 20,000 inhabitants	7,239	2,481	4,758	6,025	1,214
The Balearic Islands	> 100,000 inhabitants	704	190	513	568	135
The Balearic Islands	50,000 - 100,000 inhabitants	-	-	-	-	-
The Balearic Islands	20,000 - 50,000 inhabitants	1,053	357	697	779	274
The Balearic Islands	< 20,000 inhabitants	1,222	431	791	801	421
Madrid	> 100,000 inhabitants	22,558	6,585	15,973	19,051	3,507
Madrid	50,000 - 100,000 inhabitants	-	-	-	-	-
Madrid	20,000 - 50,000 inhabitants	-	-	-	-	-
Madrid	< 20,000 inhabitants	-	-	-	-	-
Navarre	> 100,000 inhabitants	1,966	480	1,486	1,761	206
Navarre	50,000 - 100,000 inhabitants	-	-	-	-	-
Navarre	20,000 - 50,000 inhabitants	307	66	242	144	163
Navarre	< 20,000 inhabitants	1,875	791	1,084	1,496	379
The Basque Country	> 100,000 inhabitants	5,077	1,579	3,498	4,209	868
The Basque Country	50,000 - 100,000 inhabitants	1,136	187	949	968	168
The Basque Country	20,000 - 50,000 inhabitants	1,140	449	691	996	145
The Basque Country	< 20,000 inhabitants	2,910	1,230	1,680	2,377	533

(Continuation TABLE 12)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Region of Murcia	> 100,000 inhabitants	4,652	1,045	3,607	4,193	459
Region of Murcia	50,000 - 100,000 inhabitants	1,207	309	898	986	221
Region of Murcia	20,000 - 50,000 inhabitants	1,403	317	1,086	1,206	197
Region of Murcia	< 20,000 inhabitants	877	282	594	717	159
La Rioja	> 100,000 inhabitants	612	94	517	517	94
La Rioja	50,000 - 100,000 inhabitants	-	-	-	-	-
La Rioja	20,000 - 50,000 inhabitants	104	21	83	53	50
La Rioja	< 20,000 inhabitants	701	304	397	452	249

Note: Metropolitan areas are included within municipalities with over 100,000 inhabitants to safeguard statistical confidentiality,

CHAPTER 3.
ANNUAL INVESTMENT IN INVENTORY RENEWAL

The aim of this chapter is to calculate the annual investment in renewal that shall be made to sustainably maintain networks and infrastructures throughout their renewal period.

To this end, used methodology is based on the renewal period of the various network and special infrastructures elements contained within the inventory. Regarding networks, the renewal period will be established for each type of material, while regarding special infrastructures, different renewal periods will be differentiated for housing development (in the case of DWTPs and WWTPs), civil works, electromechanical equipment, and instrumentation and control.

Based on the current value obtained in Episode 2, and the renewal period for each element, the annual renewal cost to sustainably maintain capital, for each one of the networks and infrastructures, broken down by Autonomous Communities and population strata, can be calculated.

In this study, three scenarios are considered when distributing the current value of networks and infrastructures throughout their renewal period. The first scenario (referred to as "baseline scenario") is obtained by evenly spreading the current value throughout the entire renewal period. This is an "ideal" scenario in which annual investment in renewal is constant throughout the renewal period and, therefore, this is the one that should be used if there is balance regarding renewal periods.

The second scenario (known as "additional scenario") is based on the fact that a large number of networks and infrastructures are older than the renewal period. This means that, besides the investment required to sustainably maintain networks and infrastructure throughout the renewal period, an additional investment is needed to recover the investment that did not take place during those years when networks and infrastructures have exceeded the renewal period.

The third scenario (referred to as "real scenario") is based on the actual annual investment in renewal that is currently underway in Spain, which is lower than that required according to the baseline scenario. Based on these current levels of investment, it is considered that there may be a reaction period up to the moment this investment is increased and that, subsequently, some years will go by between the current annual investment and the realisation of the annual baseline scenario investment.

3.1. BASELINE SCENARIO

With regards to the baseline scenario, the total cost of renewing networks and infrastructures is continuously distributed throughout the renewal period, as shown in Figure 9 (on next page). Therefore, the annual investment in renewal is obtained by dividing the total renewal cost by the renewal period, as stated in equation (7):

$$\textit{Baseline scenario annual investment} = \frac{\textit{Renewal cost}}{\textit{Renewal period}} \qquad (7)$$

The methodology used to achieve the annual investment in renewal for this baseline scenario, in the case of networks and special infrastructures, is explained below. Subsequently, obtained results are detailed.

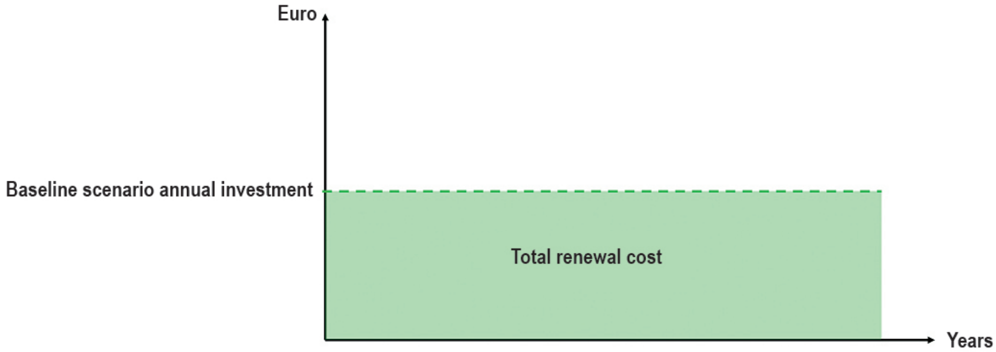


Figure 9. Outline of the calculation of the baseline scenario annual investment.

3.1.1. Methodology used for networks

In order to obtain the investment in renewal for water supply and sanitation networks, firstly, it is necessary not only to know the current redevelopment value that would result from deploying again those same networks, keeping their characteristics intact (as-new replacement value), but also the value that would result from renewing them taking into account current technical criteria (renewal cost).

The following technical criteria were taken into account to calculate this network renewal cost. Firstly, FC pipelines are replaced by PE ones, as recommended by AEAS (2017) regarding the renewal of pipelines. In this regard, it should be noted that, on average, PE is 3% cheaper than FC in relation to water supply, but twice as expensive when talking about sanitation (as can be seen in Appendix D). However, these figures vary according to diameters and population strata.

Secondly, it has been assumed that part of these pipelines is to be renewed using trenchless technology. Specifically, small diameter pipelines are fully renewed using trench digging, since trenchless technology is not usually applied to small diameters. However, medium and large diameter pipelines are renewed partly by digging and partly using trenchless technology. The percentage of trenchless technology use is set at 5% for medium diameters and 10% for larger ones.

In order to obtain trenchless work units prices, various projects using trenchless technologies were analysed (listed in Appendix C), to establish a ratio between the trenchless work unit and the work unit using digging (considered to be the sum of pipeline and civil works prices). The other prices (deployment and accessories) are considered to be similar for both technologies.

Since the number of trenchless technology projects is reduced, the comparison of work units is done nationwide without distinguishing between material type or diameter. Regarding water supply, the trenchless technology price is 1.28 times the price of digging. By contrast, in relation to sanitation, the trenchless technology price is 0.25 times the price of digging. Disparity between these two figures is due to the usual diameters for each process: regarding water supply, diameter ranges are smaller, so that civil works savings are not significant; conversely, concerning sanitation, larger diameters are used, thus trenchless technologies save higher civil works costs.

However, literature has noted that trenchless technologies generally account for a 10-30% decrease in costs when compared to digging (Arce Obregon, 2016; Najafi and Kim, 2004). Therefore, considering the analysed projects and the content of technical literature, the trenchless work unit regarding water supply is set to be 15% more expensive, while concerning sanitation it is 20% cheaper.

The renewal cost for water supply and sanitation networks, as detailed in Table 13 is obtained by applying these two criteria (replacing FC with PE and using trenchless technology).

Table 13. Renewal cost of water supply and sanitation networks (expressed in € millions), broken down by Autonomous Community and population strata

	TOTAL	WATER SUPPLY NETWORKS	SANITATION NETWORKS
Total	**166,129**	**36,572**	**129,557**
ACs:			
Andalusia	27,616	5,837	21,779
Aragon	4,438	803	3,636
Asturias	3,377	994	2,383
The Canary Islands	6,141	1,947	4,193
Cantabria	1,783	377	1,406
Castile and Leon	13,404	2,473	10,931
Castile-La Mancha	9,755	2,004	7,750
Catalonia	21,178	4,180	16,997
Valencian Community	20,395	4,073	16,322
Extremadura	5,062	925	4,136
Galicia	12,633	2,681	9,952
The Balearic Islands	2,210	572	1,638
Madrid	18,635	5,021	13,615
Navarre	3,279	859	2,421
The Basque Country	8,287	2,138	6,149
Region of Murcia	6,953	1,496	5,457
La Rioja	985	193	792
Strata:			
Metropolitan areas	38,984	9,761	29,223
> 100,000 inhabitants	30,339	5,587	24,752
50,000 - 100,000 inhabitants	19,247	3,808	15,439
20,000 - 50,000 inhabitants	21,208	5,374	15,835
< 20,000 inhabitants	56,351	12,042	44,309

In the case of the water supply network, the cost that would result from renewing this network today under current technical criteria is €36,572 million, while the cost of renewing the sanitation one amounts to €129,557 million. It is verified that, in both cases, the cost of renewing the water supply network is slightly higher than its current value (see Table 9). Regarding water supply, this is due to the fact that trenchless technology is more costly than renewal using digging. By contrast, regarding sanitation, trenchless technology is cheaper and the higher cost of renewal is due to the higher price of PE. In any case, the difference between the as-new replacement value and the renewal cost is minor. In addition, it was found that, similarly to the case of the current value, most renewal costs (both regarding water supply and sanitation) are concentrated in those Autonomous Communities and population strata with the highest number of inhabitants.

Once the cost of renewal for water supply and sanitation networks has been obtained, the next step is to calculate the annual cost of renewal, based on information about their renewal period. Specifically, in order to achieve the annual cost of renewal under the baseline scenario, it is necessary to know the renewal period for each network, according to each material type and stratum of the population. This information comes from the "2018 Survey on the condition of water infrastructures in Spain", which enquired service providers on network renewal period, broken down by materials and diameters.

On the basis of this information, two complementary procedures were followed in order to calculate renewal periods:

- Technical renewal period according to the survey of service providers.
- Renewal period based on theoretical limits

The first procedure consisted in taking the renewal periods stated in the results of the above survey, ruling some atypical ones, which were extremely reduced. Results obtained using this procedure are shown in Table 14, for each one of the materials used in water supply and sanitation networks, and according to population strata.

Table 14. Renewal period (expressed in years) of each network material, broken down by strata of population, according to the survey of service providers

	WATER SUPPLY NETWORK						SANITATION NETWORK					
	FC (renewed Using PE)	Ductile iron	Concrete	PE	PVC	Others	FC (renewed Using PE)	Ductile iron	Concrete	PE	PVC	Others
Total	**66**	**96**	**75**	**42**	**46**	**65**	**29**	**46**	**66**	**44**	**50**	**46**
Strata:												
Metropolitan areas	70	100	75	45	50	68	25	46	75	50	50	46
> 100,000 inhabitants	54	88	75	34	38	58	30	39	75	30	30	30
50,000 - 100,000 inhabitants	70	100	75	45	50	68	25	49	75	50	50	46
20,000 - 50,000 inhabitants	66	94	74	42	43	64	20	33	30	35	55	25
< 20,000 inhabitants	70	100	75	45	50	68	46	65	77	53	55	25

However, renewal periods obtained in this way, known as "*technical renewal period according to the survey of service providers*", result in investment requirementsinvestment needs that are, in some cases, far different from the reality of water supply and sanitation systems and sanitation, and are probably considered impracticable in reality.

With the aim of obtaining a comparative range, a second procedure, called "*renewal period based on theoretical limits*", was followed, so that by appropriate technical consultation, this period is defined as the largest one in which water supply and sanitation systems are not unsustainably compromised due to the aging and degradation of infrastructures.

It is important to note that periods obtained in both cases are based on the technical estimate provided by experts in the urban water field, and that a calculation process solely based on the durability and degradation technical criteria for infrastructures was followed, whether real estate or electromechanical or technological equipment. Thus, estimates by other actors that may disturb or alter the estimation of these periods fall outside the scope of this study.

On the other hand, it is also necessary to note that the obtained periods are a statistical approximation based on the responses to the conducted survey and, therefore, these are not the authoritative reflection of any water supply and sanitation system in particular. These periods provide very accurate information on the total average of all infrastructures existing in Spain, as well as its renewal needs, based on these estimated periods.

However, depending on the service provider and system to be compared to these data, results may be an approximation (close, but not precise). The aforementioned is without prejudice to the establishment of specific renewal periods based on the work of service provider technicians according to their knowledge, experience, inventory, water quality and as many variables to be considered in their corresponding analysis; these periods may be used where appropriate to conduct studies on the investment needs of infrastructures under their management.

Taking these two procedures for obtaining renewal periods into account, subsequently these are applied to the proportion of materials within each Autonomous Community, in order to calculate the average renewal period of water supply and sanitation networks, broken down by population strata and Autonomous Communities.

Using this information, regarding each stratum of population within each Autonomous Community, the renewal cost of each material is divided by the renewal period of such material (expressed in years), to obtain their annual renewal cost, as detailed in Equation (7). The annual cost of total renewal is the sum of the annual renewal costs of all materials.

Finally, in the case of the water conveyance network, in the absence of more accurate information, the process is as follows: regarding each stratum of population within each Autonomous Community, the as-new replacement value of the network has been divided by the average renewal period of the water supply network, to calculate the annual investment in renewal.

3.1.2. Methodology used for special infrastructures

In order to calculate the annual investment in renewal for special infrastructures, the first step is to obtain the renewal period for each infrastructure, distinguishing between the renewal periods of the following components: housing development (in the case of DWTPs and WWTPs), civil works, electromechanical equipment, and instrumentation and control.

To this end, similar to the approach followed regarding networks, based on the information obtained from the "2018 Survey on the condition of water infrastructures in Spain", which specifically enquired respondents on this matter, two complementary procedures were used. The first one consists in using the renewal periods stated in this survey, ruling some atypical ones, which were extremely reduced. The second procedure, based on theoretical limits, intends to adjust those renewal periods to higher ones, around 60 years, so that these are more in line with those currently being applied. The results of applying these two procedures are presented Table 15.

Table 15. Renewal period for each infrastructures component (expressed in years)

AS PER SURVEY CONDUCTED AMONG SERVICE PROVIDERS						
	DWTPs	Storage facilities	Storm water tanks	WWTPs	DWPSs	WWPSs
Construction	75	-	-	75	-	-
Civil Works	70	75	77	53	80	53
Electromechanical equipment	30	33	28	17	37	19
Instrumentation and control	20	20	18	20	25	13
ACCORDING TO THEORETICAL LIMITS						
	DWTPs	Storage facilities	Storm water tanks	WWTPs	DWPSs	WWPSs
Construction	113	-	-	131	-	-
Civil Works	105	94	96	93	120	92
Electromechanical equipment	45	41	35	30	55	33
Instrumentation and control	30	25	23	35	38	22

Information presented in Table 16, on the percentage of the cost of each infrastructure corresponding to each of mentioned component, comes from the same "2018 Survey on the condition of water infrastructure in Spain". The current value of each infrastructure component is obtained based on this information.

Subsequently, by dividing the current value of each component by the renewal period of each component, as detailed in Equation (7), the ideal annual renewal cost of each infrastructure is calculated, broken down by Autonomous Community and population stratum.

Table 16. Proportion of the total current value (expressed in %) of each special infrastructures component

	PROPORTION OF TOTAL CURRENT VALUE					
	DWTPs	Storage facilities	Storm water tanks	WWTPs	DWPSs	WWPSs
Construction	16	-	-	13	-	-
Civil Works	43	87	89	40	45	51
Electromechanical equipment	31	7	8	37	42	37
Instrumentation and control	10	5	3	10	13	12

3.1.3. Results

Results of the annual investment in renewal under the baseline scenario are shown in Table 17, for the national total, broken down by Autonomous Communities and population strata, according to the two procedures used to obtain renewal periods. In addition, these results are broken down by urban water cycle stage (water supply and sanitation) and type (networks and infrastructures).

Table 17 shows that the ideal annual investment, that is, the investment constantly required annually to sustainably maintain networks and special infrastructures within the inventory throughout their renewal period, varies, depending on the criteria used to obtain the renewal periods, from €2,221 to €3,858 million. Thus, it is proven that most of the annual investment in renewal shall be allocated to sanitation, rather than to water supply. Similarly, the annual investment to be allocated to networks is far superior to that required for special infrastructures.

Table 17. Current investment in renewal for all inventory (expressed in € millions), broken down by Autonomous Community and population strata. Baseline scenario results

	AS PER SURVEY CONDUCTED AMONG SERVICE PROVIDERS				
	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Total	**3,858**	**995**	**2,863**	**2,874**	**984**
ACs:					
Andalusia	645	154	491	493	152
Aragon	111	41	70	67	45
Asturias	92	30	62	69	23
The Canary Islands	159	54	105	117	41
Cantabria	45	12	33	31	14
Castile and Leon	333	129	204	218	116
Castile-La Mancha	214	59	155	161	53

(Continuation TABLE 17)

Catalonia	529	116	413	396	133
Valencian Community	467	100	367	363	104
Extremadura	112	26	86	82	30
Galicia	284	70	214	232	52
The Balearic Islands	72	17	55	48	25
Madrid	365	82	283	269	96
Navarre	72	18	54	53	19
The Basque Country	172	48	124	131	41
Region of Murcia	160	32	128	128	32
La Rioja	27	8	20	17	10
Strata:					
Metropolitan areas	747	179	568	577	169
> 100,000 inhabitants	722	120	602	555	167
50,000 - 100,000 inhabitants	369	70	299	285	84
20,000 - 50,000 inhabitants	710	107	603	591	119
< 20,000 inhabitants	1,311	520	792	866	445
ACCORDING TO THEORETICAL LIMITS					
	TOTAL INVENTORY	**WATER SUPPLY**	**SANITATION**	**NETWORKS**	**INFRASTRUCTURE**
Total	**2,221**	**733**	**1,488**	**1,590**	**632**
ACs:					
Andalusia	360	113	247	264	96
Aragon	72	31	41	42	30
Asturias	49	21	28	33	15
The Canary Islands	87	36	50	60	27
Cantabria	26	9	17	17	9
Castile and Leon	203	88	115	125	78
Castile-La Mancha	122	38	84	88	34
Catalonia	287	86	201	202	85
Valencian Community	259	74	184	194	65
Extremadura	65	18	47	46	19
Galicia	156	46	109	122	33
The Balearic Islands	38	12	26	23	15
Madrid	246	77	169	186	61
Navarre	44	15	29	32	12
The Basque Country	106	40	66	79	28
Region of Murcia	86	23	63	67	19
La Rioja	16	5	11	9	7
Strata:					
Metropolitan areas	498	160	337	389	108
> 100,000 inhabitants	401	92	309	299	102
50,000 - 100,000 inhabitants	224	54	170	172	53
20,000 - 50,000 inhabitants	268	78	190	195	73
< 20,000 inhabitants	831	349	482	535	296

These tables compile annual needs in accordance with the practical and theoretical criteria used to ensure the sustainability of those systems and infrastructures at the centre of urban water services. It should be noted that criteria based on the survey of service providers are more practical and realistic, since these take into account the experience of experts, who maintain and preserve infrastructures and consider the effects of obsolescence and other circumstances (town planning and land-use modifications). Criteria based on Theoretical Limits Theorists conform to more optimistic and ideal technical premises and set the maximum renewal periods, or the minimum annual investment needs, and imply excellent maintenance and conservation actions, as well as the use of very refined methodologies regarding asset management, which nowadays are only within the reach of industry leaders.

Regarding Autonomous Communities, it is observed that Andalusia, Catalonia, Valencia and Madrid are those where the greatest annual investment is required. In addition, this pattern is present within the two urban water cycle stages, and regarding networks and infrastructures. By contrast, the Autonomous Communities with the lowest annual investment needs in renewal are La Rioja, Cantabria, the Balearic Islands and Navarre.

With regards to strata of population, municipalities with less than 20,000 inhabitants accumulate most of the annual investment in renewal, for Spain as a whole (between 34% and 37%, depending on the criteria used), followed by metropolitan areas (between 19% and 22%); these are strata with a larger number of people and municipalities in Spain and, therefore, a higher number of networks and infrastructures, as proven in Chapters 1 and 2.

Similar to the current value obtained in Chapter 2, greater detail is provided in Tables 18 and 19, which show the annual investment in renewal for each stratum of population within each Autonomous Community, using the two different criteria explained to calculate renewal periods (Survey of service providers and Theoretical Limits). In addition, it is also interesting to know the annual investment to be allocated by each municipality. To this end, Tables A.6 and A.7 within Appendix A show the annual investment in renewal for a "standard municipality" (or average municipality) of each stratum of the population within each Autonomous Community, according to the two different procedures used to obtain renewal periods. Thus, similarly, Table A.5 within Appendix A, and Tables A.6 and A.7 within Appendix A, are very useful tools for municipalities, since by locating a particular municipality in the corresponding stratum of population and Autonomous Community, an estimation of the investment required annually to sustainably maintain their urban water cycle networks and infrastructures throughout their renewal period can be made.

Table 18. Annual investment in renewal (expressed in € millions) under the baseline scenario, achieved using the technical renewal period based on the survey of service providers. Results are broken down according to Autonomous Community and stratum (subsets of population)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURES
Andalusia	> 100,000 inhabitants	237.05	45.43	191.62	189.36	47.68
Andalusia	50,000 - 100,000 inhabitants	89.17	18.61	70.56	75.37	13.80
Andalusia	20,000 - 50,000 inhabitants	128.59	19.55	109.03	105.42	23.16
Andalusia	< 20,000 inhabitants	190.31	70.66	119.65	123.21	67.11

(Continuation TABLE 18)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURES
Aragon	> 100,000 inhabitants	23.99	6.71	17.27	17.90	6.09
Aragon	50,000 - 100,000 inhabitants	6.13	0.73	5.39	3.06	3.06
Aragon	20,000 - 50,000 inhabitants	9.94	1.41	8.54	5.21	4.74
Aragon	< 20,000 inhabitants	71.41	32.33	39.08	40.47	30.95
Asturias	> 100,000 inhabitants	42.34	7.17	35.17	35.55	6.79
Asturias	50,000 - 100,000 inhabitants	6.31	1.77	4.54	4.57	1.74
Asturias	20,000 - 50,000 inhabitants	14.27	2.39	11.88	11.19	3.08
Asturias	< 20,000 inhabitants	28.73	18.55	10.19	17.24	11.49
The Canary Islands	> 100,000 inhabitants	69.63	16.42	53.21	60.03	9.61
The Canary Islands	50,000 - 100,000 inhabitants	18.40	5.00	13.39	14.10	4.29
The Canary Islands	20,000 - 50,000 inhabitants	37.52	14.21	23.31	29.31	8.21
The Canary Islands	< 20,000 inhabitants	32.97	18.15	14.82	13.66	19.30
Cantabria	> 100,000 inhabitants	12.90	1.81	11.09	8.32	4.58
Cantabria	50,000 - 100,000 inhabitants	3.84	0.79	3.05	2.58	1.26
Cantabria	20,000 - 50,000 inhabitants	8.07	1.15	6.92	6.62	1.45
Cantabria	< 20,000 inhabitants	20.40	8.60	11.80	13.73	6.67
Castile and Leon	> 100,000 inhabitants	58.03	8.70	49.33	43.21	14.82
Castile and Leon	50,000 - 100,000 inhabitants	23.84	5.50	18.34	18.92	4.91
Castile and Leon	20,000 - 50,000 inhabitants	17.03	1.85	15.17	12.95	4.07
Castile and Leon	< 20,000 inhabitants	234.34	113.15	121.20	142.47	91.87
Castile-La Mancha	> 100,000 inhabitants	13.27	1.95	11.32	8.31	4.96
Castile-La Mancha	50,000 - 100,000 inhabitants	21.33	4.37	16.95	15.90	5.42
Castile-La Mancha	20,000 - 50,000 inhabitants	36.96	4.88	32.08	29.67	7.29
Castile-La Mancha	< 20,000 inhabitants	142.32	47.63	94.68	107.13	35.18

(Continuation TABLE 18)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURES
Catalonia	> 100,000 inhabitants	163.54	28.83	134.71	116.21	47.33
Catalonia	50,000 - 100,000 inhabitants	52.15	7.50	44.64	35.48	16.67
Catalonia	20,000 - 50,000 inhabitants	160.11	16.94	143.17	143.00	17.11
Catalonia	< 20,000 inhabitants	152.81	62.32	90.50	101.36	51.45
Valencian Community	> 100,000 inhabitants	181.55	38.65	142.90	141.67	39.88
Valencian Community	50,000 - 100,000 inhabitants	55.23	8.03	47.20	40.64	14.59
Valencian Community	20,000 - 50,000 inhabitants	118.07	17.20	100.87	104.53	13.54
Valencian Community	< 20,000 inhabitants	111.95	35.76	76.19	76.31	35.64
Extremadura	> 100,000 inhabitants	11.02	2.06	8.95	9.45	1.57
Extremadura	50,000 - 100,000 inhabitants	12.42	3.08	9.33	9.52	2.89
Extremadura	20,000 - 50,000 inhabitants	17.24	2.27	14.97	14.67	2.58
Extremadura	< 20,000 inhabitants	71.53	18.52	53.01	48.82	22.71
Galicia	> 100,000 inhabitants	57.69	8.21	49.47	46.49	11.20
Galicia	50,000 - 100,000 inhabitants	39.13	7.30	31.83	36.75	2.37
Galicia	20,000 - 50,000 inhabitants	56.75	7.53	49.22	48.52	8.23
Galicia	< 20,000 inhabitants	130.03	46.70	83.34	100.14	29.89
The Balearic Islands	> 100,000 inhabitants	17.43	3.21	14.22	13.06	4.37
The Balearic Islands	50,000 - 100,000 inhabitants	-	-	-	-	-
The Balearic Islands	20,000 - 50,000 inhabitants	28.62	5.71	22.90	20.29	8.32
The Balearic Islands	< 20,000 inhabitants	26.11	8.20	17.91	14.20	11.91
Madrid	> 100,000 inhabitants	364.53	81.98	282.55	268.80	95.73
Madrid	50,000 - 100,000 inhabitants	-	-	-	-	-
Madrid	20,000 - 50,000 inhabitants	-	-	-	-	-
Madrid	< 20,000 inhabitants	-	-	-	-	-

(Continuation TABLE 18)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURES
Navarre	> 100,000 inhabitants	35.57	6.70	28.87	30.68	4.89
Navarre	50,000 - 100,000 inhabitants	-	-	-	-	-
Navarre	20,000 - 50,000 inhabitants	8.05	0.83	7.22	3.17	4.88
Navarre	< 20,000 inhabitants	28.28	10.48	17.80	19.40	8.88
The Basque Country	> 100,000 inhabitants	82.61	22.17	60.45	63.36	19.25
The Basque Country	50,000 - 100,000 inhabitants	18.89	2.29	16.60	13.58	5.31
The Basque Country	20,000 - 50,000 inhabitants	27.41	5.47	21.95	22.85	4.57
The Basque Country	< 20,000 inhabitants	43.05	17.96	25.09	30.91	12.14
Region of Murcia	> 100,000 inhabitants	85.19	16.79	68.40	70.86	14.33
Region of Murcia	50,000 - 100,000 inhabitants	22.11	4.72	17.39	14.40	7.70
Region of Murcia	20,000 - 50,000 inhabitants	38.21	5.17	33.03	32.34	5.87
Region of Murcia	< 20,000 inhabitants	14.57	5.20	9.37	10.44	4.13
La Rioja	> 100,000 inhabitants	11.84	1.79	10.05	8.94	2.90
La Rioja	50,000 - 100,000 inhabitants	-	-	-	-	-
La Rioja	20,000 - 50,000 inhabitants	3.14	0.32	2.81	1.43	1.70
La Rioja	< 20,000 inhabitants	12.41	5.44	6.97	6.66	5.75

Note: Metropolitan areas are included within municipalities with over 100,000 inhabitants to safeguard statistical confidentiality.

Table 19. Annual investment in renewal (expressed in € millions) under the baseline scenario, achieved using the renewal period based on theoretical limits. Results are broken down according to Autonomous Community and stratum (subsets of population)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURES
Andalusia	> 100,000 inhabitants	138.36	38.14	100.22	109.38	28.99
Andalusia	50,000 - 100,000 inhabitants	53.77	13.93	39.85	44.89	8.89
Andalusia	20,000 - 50,000 inhabitants	48.24	14.07	34.17	34.03	14.21
Andalusia	< 20,000 inhabitants	119.36	46.84	72.52	75.60	43.76
Aragon	> 100,000 inhabitants	16.78	5.98	10.80	12.77	4.01
Aragon	50,000 - 100,000 inhabitants	3.67	0.56	3.10	1.88	1.78
Aragon	20,000 - 50,000 inhabitants	4.59	1.00	3.60	1.83	2.77
Aragon	< 20,000 inhabitants	47.37	23.57	23.80	25.75	21.62
Asturias	> 100,000 inhabitants	20.88	5.33	15.55	16.57	4.31
Asturias	50,000 - 100,000 inhabitants	4.11	1.51	2.60	2.99	1.12
Asturias	20,000 - 50,000 inhabitants	5.80	1.87	3.93	3.94	1.86
Asturias	< 20,000 inhabitants	18.09	11.87	6.22	9.94	8.15
The Canary Islands	> 100,000 inhabitants	37.31	11.10	26.21	30.92	6.39
The Canary Islands	50,000 - 100,000 inhabitants	10.69	3.57	7.12	7.90	2.79
The Canary Islands	20,000 - 50,000 inhabitants	17.83	9.46	8.37	12.39	5.44
The Canary Islands	< 20,000 inhabitants	20.92	12.14	8.78	8.37	12.55
Cantabria	> 100,000 inhabitants	7.63	1.44	6.19	4.89	2.74
Cantabria	50,000 - 100,000 inhabitants	2.25	0.55	1.70	1.49	0.75
Cantabria	20,000 - 50,000 inhabitants	3.02	0.69	2.32	2.14	0.88
Cantabria	< 20,000 inhabitants	13.06	5.83	7.23	8.50	4.56
Castile and Leon	> 100,000 inhabitants	32.18	7.11	25.07	22.95	9.23
Castile and Leon	50,000 - 100,000 inhabitants	15.38	4.41	10.97	12.07	3.31
Castile and Leon	20,000 - 50,000 inhabitants	6.46	1.49	4.98	4.03	2.44

(Continuation TABLE 19)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURES
Castile and Leon	< 20,000 inhabitants	149.19	75.14	74.05	86.30	62.88
Castile-La Mancha	> 100,000 inhabitants	8.02	1.58	6.44	5.11	2.91
Castile-La Mancha	50,000 - 100,000 inhabitants	13.43	3.64	9.79	10.10	3.33
Castile-La Mancha	20,000 - 50,000 inhabitants	13.67	3.44	10.23	9.32	4.35
Castile-La Mancha	< 20,000 inhabitants	86.79	29.34	57.45	63.82	22.97
Catalonia	> 100,000 inhabitants	101.02	23.70	77.32	72.74	28.29
Catalonia	50,000 - 100,000 inhabitants	32.77	5.97	26.79	21.68	11.09
Catalonia	20,000 - 50,000 inhabitants	53.94	13.19	40.74	43.40	10.54
Catalonia	< 20,000 inhabitants	99.00	42.67	56.33	64.25	34.75
Valencian Community	> 100,000 inhabitants	113.15	30.95	82.20	88.04	25.11
Valencian Community	50,000 - 100,000 inhabitants	33.20	6.14	27.06	24.58	8.62
Valencian Community	20,000 - 50,000 inhabitants	41.70	12.52	29.18	33.38	8.32
Valencian Community	< 20,000 inhabitants	70.88	24.83	46.05	47.93	22.95
Extremadura	> 100,000 inhabitants	6.22	1.32	4.89	5.20	1.02
Extremadura	50,000 - 100,000 inhabitants	8.11	2.74	5.37	6.34	1.77
Extremadura	20,000 - 50,000 inhabitants	6.13	1.60	4.54	4.58	1.55
Extremadura	< 20,000 inhabitants	44.55	12.54	32.00	30.30	14.25
Galicia	> 100,000 inhabitants	31.94	6.66	25.28	25.01	6.93
Galicia	50,000 - 100,000 inhabitants	22.34	6.08	16.26	20.78	1.56
Galicia	20,000 - 50,000 inhabitants	22.10	5.01	17.10	17.25	4.86
Galicia	< 20,000 inhabitants	79.19	28.36	50.83	59.46	19.73

(Continuation TABLE 19)

ACs	STRATA	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURES
The Balearic Islands	> 100,000 inhabitants	9.28	2.43	6.85	6.69	2.59
The Balearic Islands	50,000 - 100,000 inhabitants	-	-	-	-	-
The Balearic Islands	20,000 - 50,000 inhabitants	12.37	4.13	8.23	7.30	5.06
The Balearic Islands	< 20,000 inhabitants	16.20	5.47	10.72	8.77	7.43
Madrid	> 100,000 inhabitants	246.27	77.42	168.85	185.70	60.57
Madrid	50,000 - 100,000 inhabitants	-	-	-	-	-
Madrid	20,000 - 50,000 inhabitants	-	-	-	-	-
Madrid	< 20,000 inhabitants	-	-	-	-	-
Navarre	> 100,000 inhabitants	20.07	5.65	14.42	16.79	3.28
Navarre	50,000 - 100,000 inhabitants	-	-	-	-	-
Navarre	20,000 - 50,000 inhabitants	4.28	0.71	3.57	1.30	2.98
Navarre	< 20,000 inhabitants	19.61	8.87	10.74	13.61	6.00
The Basque Country	> 100,000 inhabitants	53.37	19.15	34.22	40.05	13.32
The Basque Country	50,000 - 100,000 inhabitants	11.47	1.99	9.48	8.28	3.18
The Basque Country	20,000 - 50,000 inhabitants	11.80	4.70	7.10	9.06	2.74
The Basque Country	< 20,000 inhabitants	29.66	14.32	15.34	21.38	8.28
Region of Murcia	> 100,000 inhabitants	49.21	12.71	36.50	40.59	8.61
Region of Murcia	50,000 - 100,000 inhabitants	13.21	3.31	9.90	8.75	4.46
Region of Murcia	20,000 - 50,000 inhabitants	14.32	3.74	10.59	10.73	3.59
Region of Murcia	< 20,000 inhabitants	9.16	3.48	5.69	6.50	2.66
La Rioja	> 100,000 inhabitants	6.60	1.15	5.45	4.85	1.75
La Rioja	50,000 - 100,000 inhabitants	-	-	-	-	-
La Rioja	20,000 - 50,000 inhabitants	1.49	0.25	1.24	0.49	1.00
La Rioja	< 20,000 inhabitants	8.02	3.79	4.23	4.11	3,91

Note: Metropolitan areas are included within municipalities with over 100,000 inhabitants to safeguard statistical confidentiality.

3.2. OTHER SCENARIOS

The baseline scenario presented in Section 3.1. offers an "ideal"scenario that should be used if there is balance regarding renewal periods. However, this scenario is unrealistic due to two reasons: the existence of a large number of networks and infrastructures that are older than the renewal period; and the fact that the actual annual investment in renewal that is currently underway in Spain is lower than that required according to the baseline scenario.

Therefore, two alternative scenarios, referred to as "additional scenario" and "real scenario" (which are closer to the current real situation), are presented below.

Regarding the so-called additional scenario, whose outline is shown in Figure 10, alongside the annual cost of renewal under the baseline scenario, an additional investment is needed to recover the investment that did not take place during those years when networks and infrastructures have exceeded the renewal period (red area). This investment shall be recovered over a period of time equal to (this study presents results with years and).

This investment follows a parabolic curve, as defined by the following equation (8):

$$Inversion\ curve = ax^2 + bx + c \tag{8}$$

Parameters a, b and c of the parable are obtained by considering these three aspects: (i) the area between this parable and the annual investment under the baseline scenario (red area) shall reflect the total additional investment to be made (whose calculation is detailed in Sections 3.2.1 and 3.2.2 for networks and special infrastructures, respectively); (ii) when $x = T_1$, the curve is not steep; and with (iii) $x = T_1$, additional investment is 0.

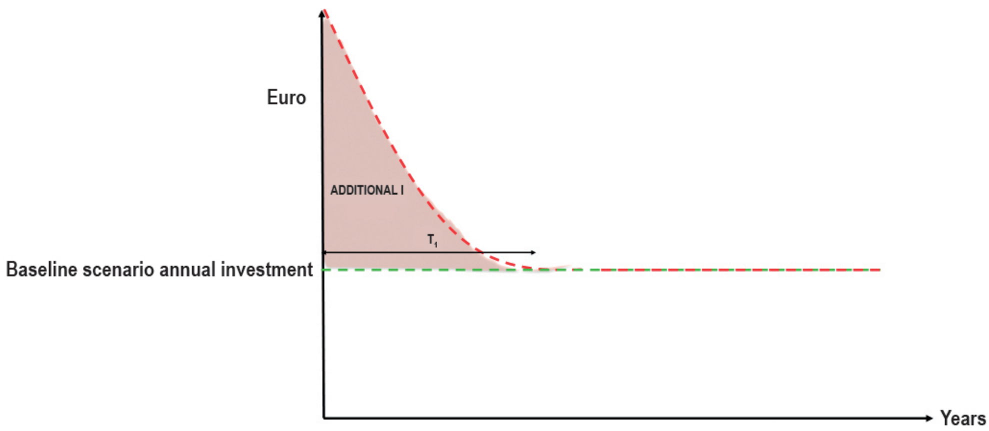


Figure 10. Calculation outline of the annual investment under the baseline scenario.

Under these conditions, a system of three equations with three parameters is obtained, as detailed in equations (9) - (11):

$$Area = \int_0^{T_1}\left(ax^2 + bx + c\right)dx = \frac{a}{3}x^3 + \frac{b}{2}x^2 + cx\Big|_0^{T_1} = \frac{a}{3}T_1^3 + \frac{b}{2}T_1^2 + cT_1 \tag{9}$$

$$\frac{d}{dx}(ax^2 + bx + c)\ 0 \Rightarrow 2ax + b|_{x=T_1} = 0 \Rightarrow b = -2T_1^2 \qquad (10)$$

$$aT_1^2 + bT + c = 0 \qquad (11)$$

Therefore, the parameters of the parabolic curve representing the additional investment are as follows:

$$\begin{cases} a = 3\dfrac{\text{Total additional investment}}{T_1^3} \\ b = -2aT_1^2 \\ c = aT_1^2 \end{cases} \qquad (12)$$

Where the "total additional investment" is equal to the red area in Figure 10, whose calculation is detailed in Sections 3.2.1 and 3.2.2 regarding networks and special infrastructures, respectively, and T_1 is the additional investment recovery period.

Finally, the outline of the so-called real scenario is shown in Figure 11. There are three different stages under this scenario: (i) an "inaction" period (T_2 period), where the annual investment being currently made is maintained (this study presents results with T_2 = 5 years and T_2 = 2 years); (ii) an "adjustment" period (T_3 period), where investment gradually increases up to the point when the ideal annual investment under the baseline scenario is reached (this study presents results with T_3 = 5 years and T_3 = 2 years); and (iii) a "recovery" period (T_4 period), where recovering both the total additional investment (as made under the additional scenario) and investment that did not take place during the adjustment years (T_2 and T_3), referred to as total adjustment investment (this study presents results with T_4 = 30 years and T_4 = 20 years) is necessary. This last stage is modelled using a parable represented by the blue area in Figure 11.

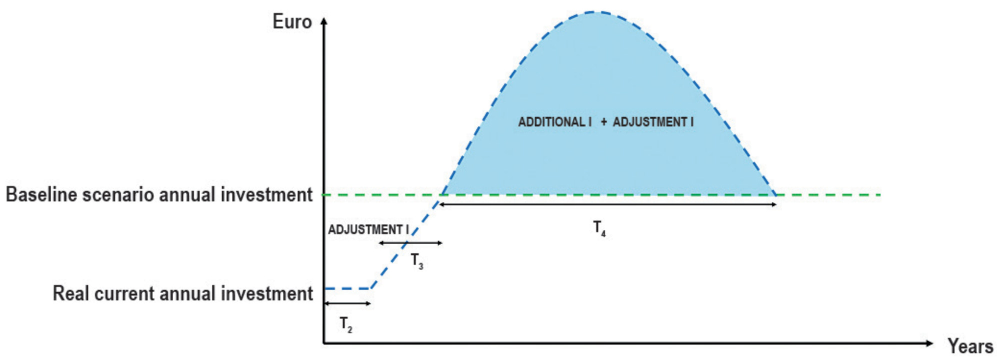


Figure 11. Calculation outline of the annual investment under the real scenario.

Therefore, according to the outline shown in Figure 11, the annual investment under the real scenario is calculated in three stages.

When $t < T_2$, investment remains constant and equal to the investment currently underway by service providers, and its calculation is detailed in Sections 3.2.1. and 3.2.2 regarding networks and special infrastructures, respectively.

When $t < T_2 < T_3$, investment follows a straight line ($ax + b$), subject to two conditions: (i) when $x = 0$, y = Current annual investment; and (ii) $x = T_3$ = Annual investment under the baseline scenario. That is:

$$\begin{cases} a = \dfrac{\textit{Baseline scenario annual investment} - \textit{Real current annual investment}}{T_3} \\ \\ b = \textit{Real current annual investment} \end{cases} \tag{13}$$

When $T_3 < t < T_4$, investment is a parable ($ax^2 + bx + c$), subject to three conditions. The first one requires the area under the curve and over the annual investment under the baseline scenario (blue area) to be equivalent to the additional investment plus the investment to be recovered during the adjustment period (T_2 and T_3). Thus, this area is:

$$Area = \int_0^{T_1} \left(ax^2 + bx + c\right)dx = \frac{a}{3}x^3 + \frac{b}{2}x^2 + cx\,\Big|_0^{T_1} = \frac{a}{3}T_1^3 + \frac{b}{2}T_1^2 + cT_1 \tag{14}$$

The second condition states that when $x = 0$, the additional investment under the baseline scenario shall be zero. That is:

$$a.\,0 + b.\,0 + c = 0 \Rightarrow c = 0 \tag{15}$$

The third condition establishes that when $x = T_4$ the additional investment under the baseline scenario is zero. That is:

$$aT_4^2 + bT_4 + c = 0 \tag{16}$$

Therefore, the three parameters of the parable can be expressed as follows:

$$\begin{cases} a = -6\dfrac{\textit{Inversión extra total} + \textit{Inversión de ajuste total}}{T_4} \\ b = -aT_4 \\ c = 0 \end{cases} \tag{17}$$

Following the explanation on how to calculate the annual investment in renewal under each one of the three scenarios, the methodology used regarding networks and special infrastructures will be presented in the following sections (Sections 3.2.1 and 3.2.2). Specifically, these detail the methodology to obtain the data required in order to know the total additional investment and real current annual investment.

3.2.1. Methodology used for networks

In order to obtain the total additional investment for water supply and sanitation networks, it is necessary to know the current average service life of these networks and whether this exceeds or not their renewal period. To this end, the data provided by AEAS National Study (2018), on the percentage of the network (both water supply and sanitation ones) that is less than 10 years old, from 11 to 20 years old, from 21 to 30 years old, from 31 and 40 years old and over 40 years old, are used as a basis. Once this information is achieved, an average age for each age range mentioned above is adopted, equal to 5, 15, 25, 35 and 80 years, respectively. In order to obtain the current average service life of these networks, these ages are multiplied by the percentage of the network within each age range. Thus, it is possible to verify whether the current average service life exceeds the renewal period regarding each stratum of population within each Autonomous Community. If so, the number of years by which the current service life has exceeded the renewal period is multiplied by the ideal annual renewal cost of that stratum within the Autonomous Community, to obtain the total additional investment.

Moreover, information on the real current annual investment has been obtained from the "2018 Survey on the condition of water infrastructures in Spain", which expressly enquired respondents on this matter. Thus, data on the real current annual investment for each stratum of population within each Autonomous Community are available; this information has been extrapolated to the total national population, using population as the raising criteria.

In the case of water conveyance networks, the same age and renewal periods as those associated to water supply networks have been considered to obtain the additional investment. In order to obatain the annual real investment, the ratio between the real current investment and the baseline scenario investment for the water supply network has been applied to the ideal annual investment of the water conveyance network.

3.2.2. Methodology used for special infrastructures

In the case of special infrastructures, the following procedure was followed to obtain the total additional investment. Firstly, information on the current average service life of special infrastructures was obtained from the "2018 Survey on the condition of water infrastructures in Spain". Regarding each component within each infrastructure, it is verified whether their current average service life exceeds the renewal period or not (according to the two criteria included in Table 15). If so, the number of years by which the current average service life has exceeded the renewal period is multiplied by the annual renewal cost of that particular component, to obtain the total additional investment in the component. The total additional investment is obtained by adding the additional investment of the various components within each infrastructure; this information is available for each infrastructure,[25] broken down by population strata and Autonomous Communities. In addition, this information has been extrapolated to the national total, using the number of municipalities (in the case of storage facilities and DWTPs) or the population (WWTPs and pumping stations) as raising criteria.

Moreover, information on the real current annual investment has been also obtained from the "2018 Survey on the condition of water infrastructures in Spain". This information, which is provided for each special infrastructure broken down by Autonomous Communities and population strata, has also been extrapolated to the national total, using the number of municipalities (in the case of storage facilities and DWTPs) or the population (WWTPs and pumping stations) as raising criteria.

3.2.3. Results

This section presents the results of the other scenarios considered in this study. Firstly, Figures 12-14 provide these results, considering that under the additional scenario, the additional investment should be recovered over 20 years (T_1); and that under the real scenario, the reaction period shall

[25] In the case of storm water tanks, available data suggests that no additional investment is necessary, since no storm water tank currently existing has an average service life that exceeds the renewal period, a fact that is hardly surprising, since these are newly constructed infrastructures.

be 5 years (T_2), the period to reach the baseline scenario is 5 years (T_3) and the period to recover the additional investment and the investment that did not take place during the adjustment period is 30 years (T_4).

Under these assumptions, Figure 12 shows the results obtained for the whole inventory under all three scenarios, according to the two procedures used to obtain the renewal periods presented in Sections 3.1.1 and 3.1.2 (survey of service providers and theoretical limits). Firstly, it is verified that, under the baseline scenario, as shown in Table 17, the annual investment in inventory renewal under the baseline scenario, for the whole of Spain, ranges from €2.2 and €3.9 billion per year, according to the renewal periods considered.

However, in addition, regarding the additional scenario, the additional investment shall be considered to recover the investment that did not take place during those years when networks or infrastructures have exceeded the renewal period. When the renewal periods stated in the survey are used, the additional investment for whole inventory amounts to €8,951 million, for Spain as a whole (approximately 4% of the current value of the inventory); this additional investment is assumed to be recovered (in addition to the ideal annual investment) over the first 20 years, as represented by the upper graph red line in Figure 12. However, when the theoretical limits criteria are employed, with higher renewal periods, the number of networks and infrastructures older than the renewal periods is drastically reduced. This results in the additional investment being decreased to €23 million, causing the lower graph red line in Figure 12 to be virtually superimposed on the investment under the baseline scenario.

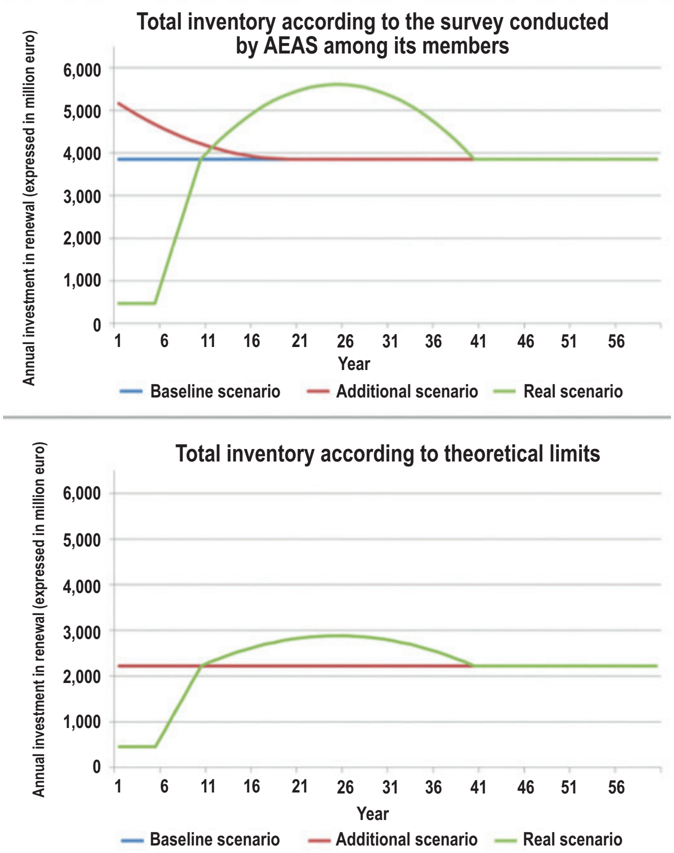


Figure 12. Annual investment in renewal for the whole inventory. Results for the three scenarios, with long adaptation periods.

Finally, regarding the real scenario, the annual investment in renewal currently underway in Spain is also taken into account. This current real annual investment amounts to €467 million, accounting for 12% to 20% of the ideal annual investment, according to the procedure used to obtain renewal periods. Thus, in this scenario, as previously mentioned, the real current annual investment is considered to be maintained over the first 5 years (assuming this period as a reaction period). From that moment on, annual investment in renewal should be gradually increased so that it reaches the investment under the baseline scenario, within 5 years. Subsequently, a 30-year period is set to recover both the additional investment and the investment that did not take place over the first 10 years, after which it reaches a maximum of between €2.9 and €5.6 billion per year, according to the procedure used to obtain renewal periods. Following those 30 years, the annual investment in renewal would become equal to that established under the baseline scenario.

The following figures show these results breaking the inventory down by water supply and sanitation services, and by networks and special infrastructures. Firstly, Figure 13 presents the results for water supply and sanitation services. Upon studying the real scenario (which is the closest one to reality), it is found that the initial real current annual investment for water supply services is approximately €282 million (approximately 28% and 38% of the ideal annual investment under the baseline scenario, according to the criteria used for renewal periods), which would be maintained over the first 5 years. Subsequently, this should be increased to reach the ideal one within another 5-year period, so that the additional investment and the investment that did not take place during the ten previous years (which, for water supply services, ranges from €23 and

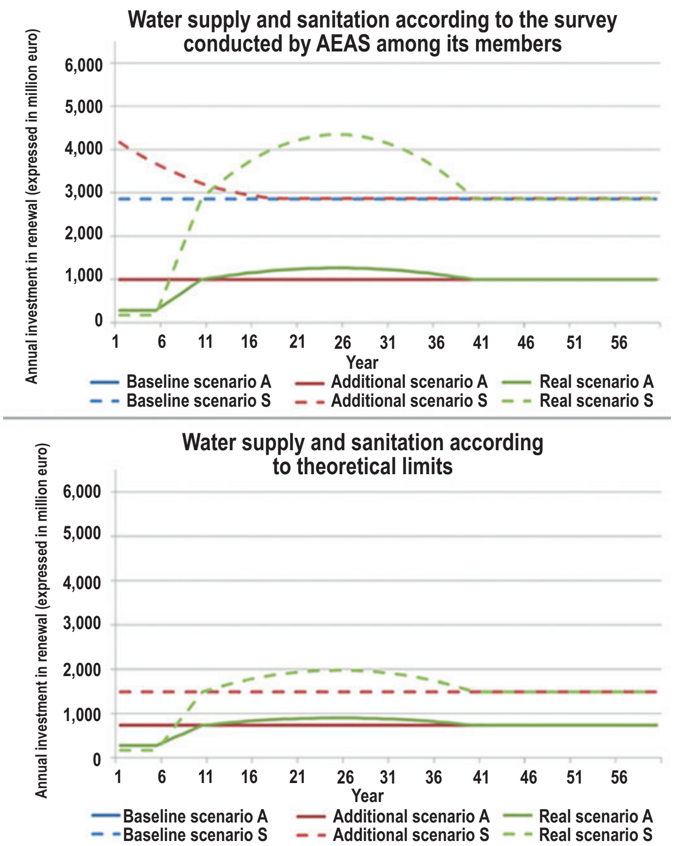


Figure 13. Annual investment in renewal for water supply and sanitation. Results for the three scenarios, with long adaptation periods.

€49 million, amounting to less than 0.1% of the current value of the water supply inventory) are subsequently recovered within 30 years. In this way, the annual investment in water supply reaches a maximum of approximately one billion euro per year. Subsequently, the annual investment in renewal would become equal to that established under the baseline scenario, which in the case of water supply amounts to €733 and €995 million, according to the renewal periods considered.

Regarding sanitation, it is found that the real current annual investment (€184 million) is particularly low, only accounting for 6% to 12% of the ideal annual investment, according to the renewal periods considered. It is surprising to note that the real current annual investment in sanitation is even lower than that in water supply; this is a worrying fact, considering that the value of the sanitation network more than doubles that of the water supply one. This means that, as seen in Figure 13, the effort to be made regarding sanitation, to achieve the baseline scenario is much higher than that regarding water supply.

Figure 14 below presents the results for networks and special infrastructures. Again, it is shocking to find that the real current annual investment in networks (approximately €261 billion per year) is almost similar to that in special infrastructures (€197 billion per year), given that the network value is over 4 times higher than the infrastructure one. This means that the effort to be made regarding networks, to achieve the baseline scenario is much higher than that for special infrastructures.

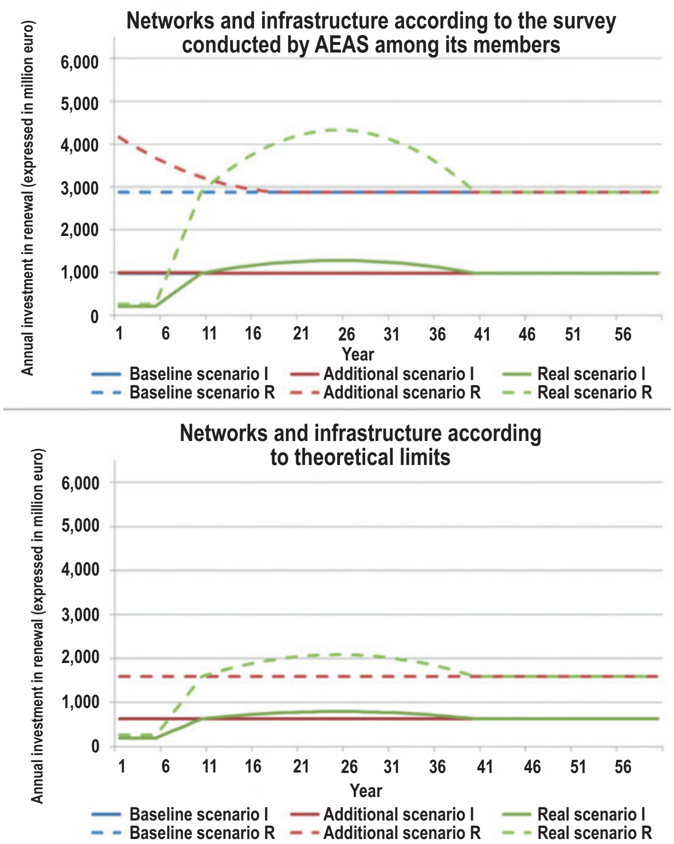


Figure 14. Annual investment in renewal for networks and infrastructures. Results for the three scenarios, with long adaptation periods.

Figures 15-17 below present the same results as Figures 12-14, but with shorter adjustment periods. That is, in this case, it is considered that, under the additional scenario, the additional investment should be recovered over 10 years (T_1); and under the real scenario, the reaction period shall be 2 years (T_2), the period to reach the baseline scenario is 2 years (T_3) and the period to recover the additional investment and the investment that did not take place during the adjustment period is 20 years (T_4). Thus, it is possible to observe the evolution of the needed annual investment in renewal, when shorter periods are considered to recover the additional investment and to move from the real current investment to the ideal one.

Figure 15, which shows the results for the whole inventory under these new hypotheses, shows how the annual investment increases when adjustment periods are reduced. This situation takes place, especially, under the additional scenario when the renewal periods are those established in the survey of service providers, with an initial investment of over €6 billion (compared to the €5 billion set for longer adjustment periods). By contrast, under the real scenario, the parable formed by the upper graph green curve in Figure 15 is not very different from that in Figure 12, since the greatest effort needed to recover the additional investment over a shorter period is offset by a lower investment due to less adjustment time passed from the initial real current situation and the ideal one.

However, when renewal periods according to theoretical limits are used, since in this case additional investment is virtually non-existent and the adjustment period between real and ideal

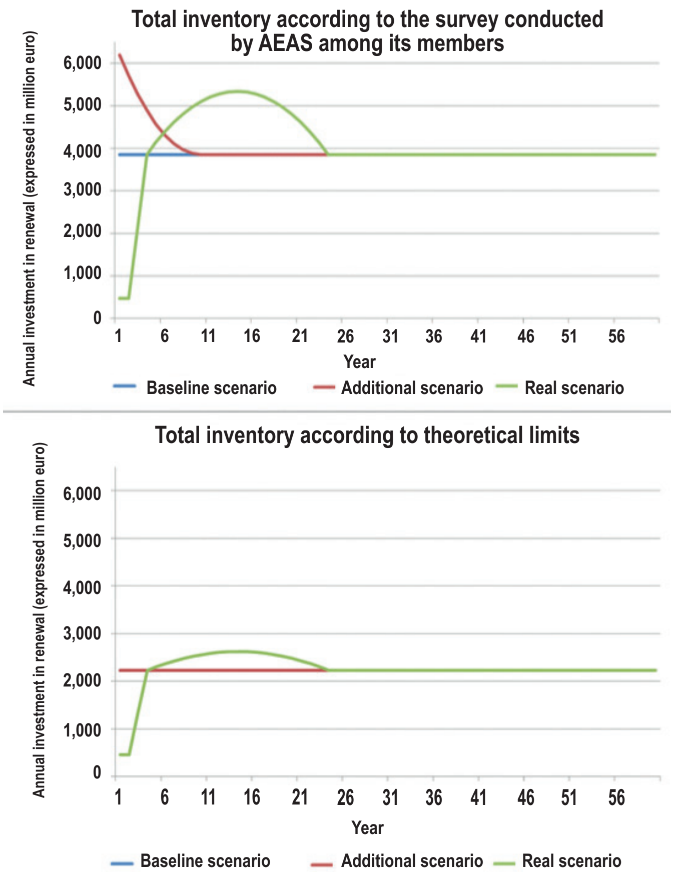


Figure 15. Annual investment in renewal for the whole inventory. Results for the three scenarios, with short adjustment periods.

current investment is reduced, the parable formed by the green curve in the graph below in Figure 15 is slightly flatter than that in Figure 12. This suggests that, when adjustment periods are reduced, the investment effort to be made over the first four years would be greater, though the investment effort over the next 20 years would be somewhat lower.

After analysing water supply and sanitation stages (Figure 16), as well as networks and infrastructures (Figure 17, on next page), a similar result is obtained. When the renewal periods established in the survey of service providers are considered, the main difference lies in the initial additional investment regarding water supply and infrastructures (in both cases, over €5 billion, compared to over €4,000 million, when longer adjustment periods are considered). Conversely, when renewal theoretical limits are considered, the main difference is that the parable formed by the green curve in the graph below in Figures 16 and 17 is slightly flatter than that in Figures 13 and 14, both regarding water supply and sanitation, as well as networks and infrastructures.

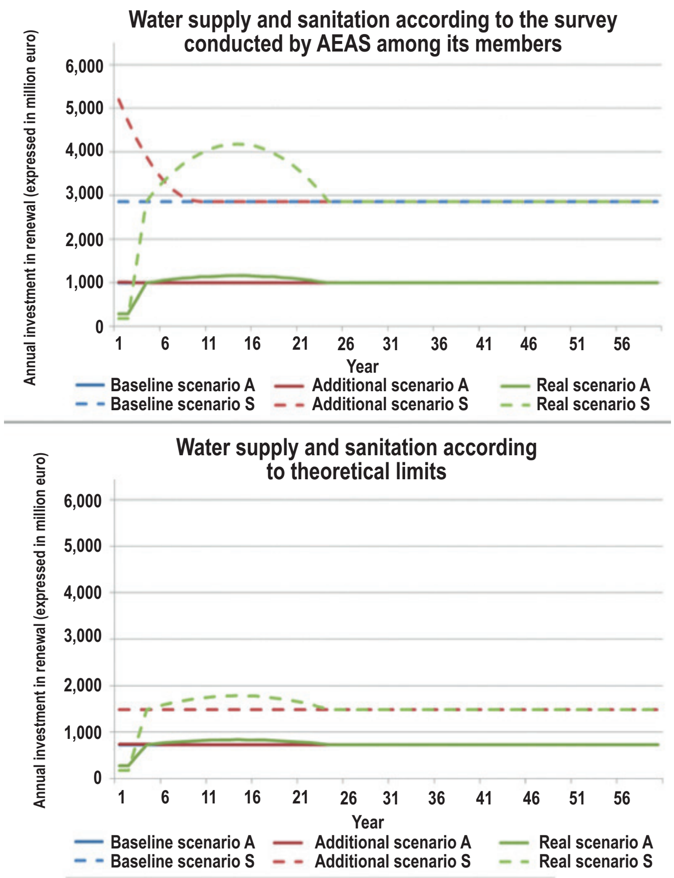
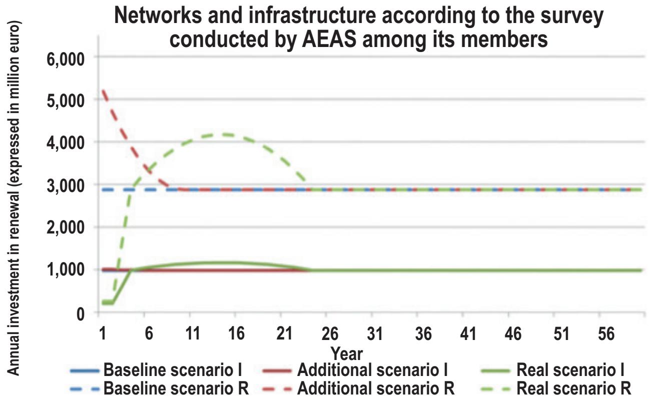


Figure 16. Annual investment in renewal for water supply and sanitation. Results for the three scenarios, with short adjustment periods.



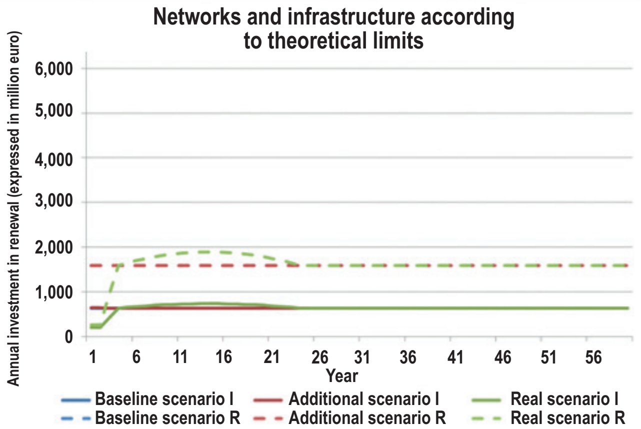


Figure 17. Annual investment in renewal for networks and infrastructures. Results for the three scenarios, with short adjustment periods.

CONCLUSIONS

- Investment needs concerning water infrastructures as a whole shall be taken into account, due to various reasons: new legal provisions that may be established and the need to achieve a good condition of water bodies, to ensure security of supply regarding water basins, and to guarantee the continuity and safety of services provided. Therefore, water policies at the national level shall ensure security of supply for all uses within the planning system, as well as the promotion and maintenance of those infrastructures that guarantee the provision of water services.
- Standard practices in this regard only draw attention to the so-called "new constructions" required to protect the resource, meet new demands, improve water quality, adapt to climate change and prevent extreme events, thus increasing security and resilience. However, it is imperative to raise awareness (among citizens and political authorities) on the renewal needs of the extraordinary infrastructures and facilities present in Spain, that is, of assets associated with water services. And, in particular, on infrastructures related to the urban water cycle (water supply and sanitation), which are characterised by legally established administrative decentralisation (which fall under the responsibility of local authorities) and their physical and economic size.
- Therefore, investment needs in urban water supply and sanitation systems shall be included as a key element within strategic investment plans by those authorities in charge of their conservation; and this element shall be quantifiable regarding all areas of management: municipal, supramunicipal, regional and national. An important part of these investment needs is related to the renewal of existing infrastructures, which are aged and, in some cases, present technical obsolescence.
- In order to address the latter issue, this study analyses urban water cycle investment needs in Spain, identifying three specific goals: crafting an inventory of those networks and special infrastructures that make up the integrated urban water cycle in its current configuration; obtaining the as-new replacement value of the cost resulting from the deployment of all these assets; and estimating the annual renewal cost to sustainably maintain these infrastructures, according to different scenarios based on their renewal period.
- Applying statistical methods to obtain the inventory, as well as estimating renewal periods, has been necessary to achieve overall figures at the national and regional level, and depending on municipality size.
- Inventory overall national data are: Water conveyance networks are 23,789 km long, water supply networks cover 248,245 km and sanitation networks extend 189,203 km; there are 1,640 DWTPs, 29,305 storage facilities, 456 storm water tanks, and 2,232 WWTPs. These infrastructures have a theoretical as-new replacement value of €5,138 million (water conveyance network), €36,059 million (water supply networks), €128,917 million (sanitation networks), €7,454 million (DWTPs), €12,188 million (storage facilities), €1,413 million (storm water tanks) and €14,466 million (WWTPs). This value, in addition to the €1,856 million associated with pumping stations, amounts to a total value of urban water cycle assets in Spain of €207,492 million. This quantity accounts for 17.79% of 2017 GDP at current prices.
- These figures, according to established renewal criteria, make it possible to quantify total annual investment needs in renewal between €2,221 and €3,858 million per year. This involves an annual outlay equivalent to between 0.19% and a 0.33% of 2017 GDP at current prices.

- The as-new replacement value, which was obtained in order to calculate their renewal cost, is based on consulting and analysing base tender budgets (whose values are based on official price tables). However, the survey conducted among service providers to perform this study appears to call for a reduction in asset value by 10% to 20% due to the economic backdrop (the downward adjustment in tenders, as well as the increases resulting from official contract settlements and officially processed complementary modifications and adjustments). Finally, since this survey participation and results were neither decisive in this respect, nor considered to be of the appropriate statistical significance, it was decided not to apply the possible reduction multiplicative coefficient in the included tables, which, in any case, would fall between 0.8 and 0.9.
- By computing similar temporary periods, renewal budgets obtained in this study can reach amounts equivalent to those associated with "new constructions" scheduled within River Basin Authorities. Therefore, the results of this paper are intended to raise awareness on overall renewal investment needs of the urban water sector, as an additional requirement besides the stipulations established within the so called "new constructions".
- According to data by AEAS (2014 NS), service providers are annually investing, charged against tariffs, €585 million in infrastructure renewal (and €791 million in new constructions). This means a 70% to 80% deficit, regarding the needs calculated in this study, is being created. This is due to the fact that most service providers are neither mandated to, nor charged with the responsibility of performing the renewal processes in relation to urban systems (which are a matter of local and/or regional competence), and these public administrations are not substantially contributing to this renewal .
- This document presents the overall values of the sector as a whole. Therefore, it does not come into conflict with the necessary asset assessment that should be conducted by water supply and sanitation service providers, to face the challenge of sustainably maintaining infrastructures and ensuring their continuity for future generations.
- This study is considered to be of special interest due to the application possibilities of the databases obtained, as well as the use of clustering methods and a statistical approximation, to obtain the inventory and assess investment needs. In addition, regarding those systems with an available inventory, in whole or in part, this study lays the foundation for a useful tool that stresses the need for action by competent authorities.
- It is considered essential for public authorities and technical service providers to implement asset management, both in terms of procedure and technology, as one of their strategic goals. Finally, this task shall not be considered completed in this study, which is intended to be taken as the starting point for the collection and analysis of systematic data, to allow for a better informed and improved decision-making.

APPENDICES

APPENDIX A
DETAILED RESULTS

Table A-1. Water supply Network inventory (expressed in km) for each type of material, Results are broken down according to Autonomous Community and stratum (subsets of population)

ACs	STRATA	Total	GRAY IRON	POLYETHYLENE	PVC	FIBRE CEMENT	CONCRETE	OTHERS
Andalusia	> 100,000 inhabitants	12,900	6,196	1,493	729	3,352	246	884
Andalusia	50,000 - 100,000 inhabitants	6,258	1,083	1,990	607	2,466	19	94
Andalusia	20,000 - 50,000 inhabitants	5,954	1,078	1,834	506	1,959	0	578
Andalusia	< 20,000 inhabitants	16,755	882	8,076	3,091	4,558	8	140
Aragon	> 100,000 inhabitants	1,295	851	44	52	281	62	5
Aragon	50,000 - 100,000 inhabitants	247	36	41	26	132	2	10
Aragon	20,000 - 50,000 inhabitants	453	54	79	55	169	0	96
Aragon	< 20,000 inhabitants	3,958	65	981	523	2,372	3	14
Asturias	> 100,000 inhabitants	1,944	749	609	80	482	2	23
Asturias	50,000 - 100,000 inhabitants	414	200	56	0	155	1	1
Asturias	20,000 - 50,000 inhabitants	698	204	86	99	297	0	13
Asturias	< 20,000 inhabitants	4,985	331	2,523	1,494	601	0	36
The Canary Islands	> 100,000 inhabitants	4,666	1,111	1,512	490	401	33	1,120
The Canary Islands	50,000 - 100,000 inhabitants	1,407	205	498	89	286	0	329
The Canary Islands	20,000 - 50,000 inhabitants	3,867	499	1,005	116	162	0	2,084
The Canary Islands	< 20,000 inhabitants	4,048	342	1,148	428	66	352	1,713
Cantabria	> 100,000 inhabitants	423	240	61	0	116	3	3
Cantabria	50,000 - 100,000 inhabitants	250	52	107	37	43	0	9
Cantabria	20,000 - 50,000 inhabitants	393	41	225	70	53	0	4
Cantabria	< 20,000 inhabitants	2,056	330	1,006	365	278	5	72
Castile and Leon	> 100,000 inhabitants	1,864	1,310	170	54	296	0	34

(Continuation TABLE A-1)

ACs	STRATA	Total	GRAY IRON	POLYETHYLENE	PVC	FIBRE CEMENT	CONCRETE	OTHERS
Castile and Leon	50,000 - 100,000 inhabitants	1,493	721	193	387	182	3	7
Castile and Leon	20,000 - 50,000 inhabitants	510	106	44	27	334	0	0
Castile and Leon	< 20,000 inhabitants	16,183	487	5,394	6,260	3,890	36	116
Castile-La Mancha	> 100,000 inhabitants	512	282	46	15	149	15	5
Castile-La Mancha	50,000 - 100,000 inhabitants	1,320	469	201	63	521	9	57
Castile-La Mancha	20,000 - 50,000 inhabitants	1,724	252	476	305	660	12	19
Castile-La Mancha	< 20,000 inhabitants	12,837	182	2,542	7,311	2,604	187	11
Catalonia	> 100,000 inhabitants	7,675	3,544	1,835	98	1,722	394	82
Catalonia	50,000 - 100,000 inhabitants	2,316	864	653	120	646	7	25
Catalonia	20,000 - 50,000 inhabitants	4,750	1,539	1,297	95	1,710	0	109
Catalonia	< 20,000 inhabitants	13,467	513	4,314	2,645	4,449	268	1,278
Valencian Community	> 100,000 inhabitants	13,237	2,774	4,426	628	4,724	114	571
Valencian Community	50,000 - 100,000 inhabitants	2,960	577	947	136	1,255	6	38
Valencian Community	20,000 - 50,000 inhabitants	5,738	1,222	2,215	172	2,008	0	121
Valencian Community	< 20,000 inhabitants	9,676	630	3,446	1,452	3,934	140	75
Extremadura	> 100,000 inhabitants	622	20	246	15	261	0	80
Extremadura	50,000 - 100,000 inhabitants	792	514	50	27	200	0	2
Extremadura	20,000 - 50,000 inhabitants	815	121	225	139	303	0	27
Extremadura	< 20,000 inhabitants	5,385	220	1,721	1,325	2,075	0	45
Galicia	> 100,000 inhabitants	1,877	1,299	278	66	199	24	11
Galicia	50,000 - 100,000 inhabitants	2,197	1,140	690	33	316	18	0
Galicia	20,000 - 50,000 inhabitants	2,613	729	1,599	112	172	0	0
Galicia	< 20,000 inhabitants	14,406	401	6,769	4,848	2,363	0	25
The Balearic Islands	> 100,000 inhabitants	988	244	118	4	614	8	1

(Continuation TABLE A-1)

ACs	STRATA	Total	GRAY IRON	POLYETHYLENE	PVC	FIBRE CEMENT	CONCRETE	OTHERS
The Balearic Islands	50,000 - 100,000 inhabitants							
The Balearic Islands	20,000 - 50,000 inhabitants	1,776	261	396	307	739	0	73
The Balearic Islands	< 20,000 inhabitants	1,874	34	713	422	648	0	56
Madrid	> 100,000 inhabitants	18,651	15,182	765	298	1,604	448	354
Madrid	50,000 - 100,000 inhabitants							
Madrid	20,000 - 50,000 inhabitants							
Madrid	< 20,000 inhabitants							
Navarre	> 100,000 inhabitants	1,478	1,160	111	7	120	52	28
Navarre	50,000 - 100,000 inhabitants							
Navarre	20,000 - 50,000 inhabitants	152	133	8	0	11	0	0
Navarre	< 20,000 inhabitants	2,582	2,143	165	8	199	46	21
The Basque Country	> 100,000 inhabitants	3,833	2,824	553	0	387	59	11
The Basque Country	50,000 - 100,000 inhabitants	570	392	112	0	62	0	4
The Basque Country	20,000 - 50,000 inhabitants	1,348	975	214	0	139	15	5
The Basque Country	< 20,000 inhabitants	4,125	2,982	656	0	425	45	16
Region of Murcia	> 100,000 inhabitants	5,645	1,789	1,157	90	2,551	17	40
Region of Murcia	50,000 - 100,000 inhabitants	2,049	348	750	330	553	0	68
Region of Murcia	20,000 - 50,000 inhabitants	1,801	166	492	182	961	0	0
Region of Murcia	< 20,000 inhabitants	1,460	112	571	274	491	1	10
La Rioja	> 100,000 inhabitants	596	93	291	11	202	0	0
La Rioja	50,000 - 100,000 inhabitants							
La Rioja	20,000 - 50,000 inhabitants	79	20	17	3	39	0	0
La Rioja	< 20,000 inhabitants	1,295	103	801	23	368	0	1

Note: Metropolitan areas are included within municipalities with over 100,000 inhabitants to safeguard statistical confidentiality.

Table A.2. Sanitation network inventory (expressed in km) for each type of material. Results are broken down according to Autonomous Community and stratum (subsets of population)

ACs	STRATA	Total	GRAY IRON	POLYETHYLENE	PVC	FIBRE CEMENT	CONCRETE	OTHERS
Andalusia	> 100,000 inhabitants	9,601	0	323	1,363	667	5,342	1,907
Andalusia	50,000 - 100,000 inhabitants	5,360	0	322	1,844	134	2,835	225
Andalusia	20,000 - 50,000 inhabitants	4,427	0	407	987	208	2,351	474
Andalusia	< 20,000 inhabitants	11,495	5	134	3,699	861	6,626	170
Aragon	> 100,000 inhabitants	1,171	0	0	153	4	973	41
Aragon	50,000 - 100,000 inhabitants	193	0	2	30	18	141	2
Aragon	20,000 - 50,000 inhabitants	208	0	2	53	19	133	1
Aragon	< 20,000 inhabitants	3,518	8	56	541	349	2,538	27
Asturias	> 100,000 inhabitants	1,726	0	40	854	78	511	243
Asturias	50,000 - 100,000 inhabitants	297	0	0	103	17	176	0
Asturias	20,000 - 50,000 inhabitants	462	0	0	151	10	291	10
Asturias	< 20,000 inhabitants	1,100	11	4	638	10	367	71
The Canary Islands	> 100,000 inhabitants	2,714	0	35	1,037	19	1,354	269
The Canary Islands	50,000 - 100,000 inhabitants	641	0	24	28	8	337	245
The Canary Islands	20,000 - 50,000 inhabitants	1,423	0	4	884	57	364	114
The Canary Islands	< 20,000 inhabitants	912	21	43	483	172	135	57
Cantabria	> 100,000 inhabitants	418	0	5	100	21	271	21
Cantabria	50,000 - 100,000 inhabitants	195	13	3	81	11	78	9
Cantabria	20,000 - 50,000 inhabitants	360	24	6	149	21	144	16
Cantabria	< 20,000 inhabitants	1,444	87	19	699	77	503	58
Castile and Leon	> 100,000 inhabitants	2,340	0	2	889	311	978	159
Castile and Leon	50,000 - 100,000 inhabitants	1,123	0	8	276	16	817	6
Castile and Leon	20,000 - 50,000 inhabitants	510	0	0	114	0	396	0
Castile and Leon	< 20,000 inhabitants	12,653	0	78	2,212	953	9,322	87

(Continuation TABLE A-2)

ACs	STRATA	Total	GRAY IRON	POLYETHYLENE	PVC	FIBRE CEMENT	CONCRETE	OTHERS
Castile-La Mancha	> 100,000 inhabitants	420	0	0	128	0	292	0
Castile-La Mancha	50,000 - 100,000 inhabitants	890	0	25	147	0	663	55
Castile-La Mancha	20,000 - 50,000 inhabitants	1,177	0	21	231	80	801	44
Castile-La Mancha	< 20,000 inhabitants	9,249	0	24	1,651	135	7,406	34
Catalonia	> 100,000 inhabitants	7,867	11	797	1,274	597	4,512	676
Catalonia	50,000 - 100,000 inhabitants	2,073	0	75	348	4	1,453	193
Catalonia	20,000 - 50,000 inhabitants	5,426	0	678	700	0	2,632	1,416
Catalonia	< 20,000 inhabitants	9,545	23	633	710	1,834	5,296	1,049
Valencian Community	> 100,000 inhabitants	8,854	0	188	938	87	4,470	3,172
Valencian Community	50,000 - 100,000 inhabitants	2,647	0	109	694	8	1,721	116
Valencian Community	20,000 - 50,000 inhabitants	4,188	0	339	804	88	2,819	138
Valencian Community	< 20,000 inhabitants	6,418	5	224	747	160	5,202	80
Extremadura	> 100,000 inhabitants	486	0	24	120	15	305	22
Extremadura	50,000 - 100,000 inhabitants	584	0	1	210	2	361	11
Extremadura	20,000 - 50,000 inhabitants	570	0	13	123	10	408	17
Extremadura	< 20,000 inhabitants	4,244	1	108	741	108	3,230	57
Galicia	> 100,000 inhabitants	2,642	0	11	1,181	193	1,197	61
Galicia	50,000 - 100,000 inhabitants	2,337	0	21	694	262	755	605
Galicia	20,000 - 50,000 inhabitants	2,839	0	20	1,687	51	798	284
Galicia	< 20,000 inhabitants	11,055	9	275	6,229	1,626	2,853	63
The Balearic Islands	> 100,000 inhabitants	869	0	22	274	364	181	29
The Balearic Islands	50,000 - 100,000 inhabitants							
The Balearic Islands	20,000 - 50,000 inhabitants	967	0	50	296	137	477	7
The Balearic Islands	< 20,000 inhabitants	1,764	0	310	635	435	320	65

(Continuation TABLE A-2)

ACs	STRATA	Total	GRAY IRON	POLYETHYLENE	PVC	FIBRE CEMENT	CONCRETE	OTHERS
Madrid	> 100,000 inhabitants	17,296	0	536	1,591	35	10,551	4,583
Madrid	50,000 - 100,000 inhabitants							
Madrid	20,000 - 50,000 inhabitants							
Madrid	< 20,000 inhabitants							
Navarre	> 100,000 inhabitants	1,671	0	2	896	3	754	17
Navarre	50,000 - 100,000 inhabitants							
Navarre	20,000 - 50,000 inhabitants	166	0	0	92	0	74	0
Navarre	< 20,000 inhabitants	1,842	0	0	1,004	2	827	9
The Basque Country	> 100,000 inhabitants	4,105	0	456	1,244	0	2,244	161
The Basque Country	50,000 - 100,000 inhabitants	968	0	0	380	0	540	47
The Basque Country	20,000 - 50,000 inhabitants	944	0	71	313	0	519	41
The Basque Country	< 20,000 inhabitants	2,861	0	215	950	0	1,574	123
Region of Murcia	> 100,000 inhabitants	3,621	0	243	1,115	163	1,981	119
Region of Murcia	50,000 - 100,000 inhabitants	739	0	14	181	0	485	58
Region of Murcia	20,000 - 50,000 inhabitants	1,598	0	27	698	0	873	0
Region of Murcia	< 20,000 inhabitants	887	2	17	146	60	661	0
La Rioja	> 100,000 inhabitants	486	0	0	201	14	270	0
La Rioja	50,000 - 100,000 inhabitants							
La Rioja	20,000 - 50,000 inhabitants	69	0	0	21	10	38	0
La Rioja	< 20,000 inhabitants	547	0	0	240	0	306	0

Note: Metropolitan areas are included within municipalities with over 100,000 inhabitants to safeguard statistical confidentiality.

Table A.3. Diameter distribution (expressed in %) for materials used in water supply and sanitation networks. Results are broken down according to stratum (subsets of population)

Material	Diameter	Strata				
		1	2	3	4	5-8
WATER SUPPLY						
FIBRE CEMENT	Large	26.86	33.80	26.97	36.26	26.23
FIBRE CEMENT	Medium	51.84	30.69	51.05	49.47	37.79
FIBRE CEMENT	Small	21.29	35.51	21.98	14.24	35.95
DUCTILE IRON	Large	13.84	11.13	14.22	18.17	11.71
DUCTILE IRON	Medium	23.84	23.22	48.88	35.04	37.94
DUCTILE IRON	Small	62.33	65.65	36.90	46.77	50.35
CONCRETE	Large	61.76	25.77	0.00	0.00	0.00
CONCRETE	Medium	37.99	72.59	50.00	0.00	100.00
CONCRETE	Small	0.26	1.64	50.00	0.00	0.00
OTHERS	Large	23.58	15.92	12.25	16.95	13.53
OTHERS	Medium	40.44	43.30	56.76	50.92	44.43
OTHERS	Small	35.99	40.78	30.99	32.11	42.03
POLYETHYLENE	Large	3.33	5.13	9.07	6.41	6.47
POLYETHYLENE	Medium	35.61	32.86	60.11	61.56	44.12
POLYETHYLENE	Small	61.05	62.01	30.82	32.01	49.40
PVC	Large	12.11	3.77	11.02	6.95	9.72
PVC	Medium	52.89	52.13	73.75	57.62	57.87
PVC	Small	35.00	44.11	15.22	35.43	32.40
SANITATION						
Material	**Diameter**	**Strata**				
		1	2	3	4	5-8
FIBRE CEMENT	Large	77.89	60.01	87.67	94.94	62.88
FIBRE CEMENT	Medium	19.42	32.80	12.33	5.06	32.95
FIBRE CEMENT	Small	2.69	7.18	0.00	0.00	4.18
DUCTILE IRON	Large	57.85	45.74	64.04	57.03	54.87
DUCTILE IRON	Medium	36.84	34.87	22.52	35.67	41.16
DUCTILE IRON	Small	5.28	19.39	13.44	7.30	3.97
CONCRETE	Large	86.77	79.02	76.35	90.32	93.47
CONCRETE	Medium	8.95	10.89	17.86	7.44	5.30
CONCRETE	Small	4.12	10.10	5.79	2.24	1.23
OTHERS	Large	20.42	5.45	38.15	11.88	0.00
OTHERS	Medium	75.37	42.43	9.54	63.39	100.00
OTHERS	Small	4.21	52.12	52.31	24.73	0.00
POLYETHYLENE	Large	83.39	75.03	76.30	58.70	85.00
POLYETHYLENE	Medium	14.10	23.64	22.94	41.30	13.78
POLYETHYLENE	Small	2.51	1.33	0.75	0.00	1.22
PVC	Large	20.78	9.21	41.71	29.31	33.03
PVC	Medium	66.35	64.58	49.94	61.14	53.77
PVC	Small	12.87	26.20	8.36	9.55	13.21

Note: Strata refer to those provided in Table 2.

Table A.4. Special infrastructures inventory (number). Results are broken down according to Autonomous Community and stratum (subsets of population)

ACs	STRATA	DWTPs	STORAGE FACILITIES
Andalusia	> 100,000 inhabitants	11	209
Andalusia	50,000 - 100,000 inhabitants	9	171
Andalusia	20,000 - 50,000 inhabitants	17	328
Andalusia	< 20,000 inhabitants	211	2,574
Aragon	> 100,000 inhabitants	1	32
Aragon	50,000 - 100,000 inhabitants	1	3
Aragon	20,000 - 50,000 inhabitants	2	24
Aragon	< 20,000 inhabitants	107	2,308
Asturias	> 100,000 inhabitants	2	76
Asturias	50,000 - 100,000 inhabitants	1	16
Asturias	20,000 - 50,000 inhabitants	2	90
Asturias	< 20,000 inhabitants	31	1,441
The Canary Islands	> 100,000 inhabitants	4	135
The Canary Islands	50,000 - 100,000 inhabitants	5	90
The Canary Islands	20,000 - 50,000 inhabitants	23	223
The Canary Islands	< 20,000 inhabitants	61	493
Cantabria	> 100,000 inhabitants	1	8
Cantabria	50,000 - 100,000 inhabitants	1	3
Cantabria	20,000 - 50,000 inhabitants	1	30
Cantabria	< 20,000 inhabitants	17	596
Castile and Leon	> 100,000 inhabitants	6	34
Castile and Leon	50,000 - 100,000 inhabitants	5	29
Castile and Leon	20,000 - 50,000 inhabitants	2	33
Castile and Leon	< 20,000 inhabitants	508	5,966
Castilla La Mancha	> 100,000 inhabitants	1	17
Castile-La Mancha	50,000 - 100,000 inhabitants	2	23
Castile-La Mancha	20,000 - 50,000 inhabitants	4	34
Castile-La Mancha	< 20,000 inhabitants	49	2,541
Catalonia	> 100,000 inhabitants	6	193
Catalonia	50,000 - 100,000 inhabitants	6	37
Catalonia	20,000 - 50,000 inhabitants	8	275
Catalonia	< 20,000 inhabitants	171	2,811
Valencian Community	> 100,000 inhabitants	4	254
Valencian Community	50,000 - 100,000 inhabitants	6	67
Valencian Community	20,000 - 50,000 inhabitants	14	177
Valencian Community	< 20,000 inhabitants	71	1,638
Extremadura	> 100,000 inhabitants	1	27
Extremadura	50,000 - 100,000 inhabitants	2	16
Extremadura	20,000 - 50,000 inhabitants	1	22
Extremadura	< 20,000 inhabitants	19	1,075

(Continuation TABLE A-4)

ACs	STRATA	DWTPs	STORAGE FACILITIES
Galicia	> 100,000 inhabitants	5	58
Galicia	50,000 - 100,000 inhabitants	1	20
Galicia	20,000 - 50,000 inhabitants	5	54
Galicia	< 20,000 inhabitants	77	1,820
Islas Baleares	> 100,000 inhabitants	3	5
Islas Baleares	50,000 - 100,000 inhabitants	-	-
Islas Baleares	20,000 - 50,000 inhabitants	7	92
Islas Baleares	< 20,000 inhabitants	28	314
Madrid	> 100,000 inhabitants	14	387
Madrid	50,000 - 100,000 inhabitants	-	-
Madrid	20,000 - 50,000 inhabitants	-	-
Madrid	< 20,000 inhabitants	-	-
Navarra	> 100,000 inhabitants	3	136
Navarra	50,000 - 100,000 inhabitants	-	-
Navarra	20,000 - 50,000 inhabitants	1	6
Navarra	< 20,000 inhabitants	6	687
País Vasco	> 100,000 inhabitants	3	238
País Vasco	50,000 - 100,000 inhabitants	1	12
País Vasco	20,000 - 50,000 inhabitants	2	38
País Vasco	< 20,000 inhabitants	48	582
Región de Murcia	> 100,000 inhabitants	6	95
Región de Murcia	50,000 - 100,000 inhabitants	1	66
Región de Murcia	20,000 - 50,000 inhabitants	6	96
Región de Murcia	< 20,000 inhabitants	16	110
La Rioja	> 100,000 inhabitants	1	5
La Rioja	50,000 - 100,000 inhabitants	-	-
La Rioja	20,000 - 50,000 inhabitants	1	3
La Rioja	< 20,000 inhabitants	11	363

Note: Metropolitan areas are included within municipalities with over 100,000 inhabitants to safeguard statistical confidentiality.

Table A.5. Current value of the entire inventory (expressed in millions of €) of the "standard municipality" for each stratum within each Autonomous Community

ACs	STRATA	MUNICIPALITIES	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Andalusia	> 100,000 inhabitants	24	527	133	393	461	65
Andalusia	50,000 - 100,000 inhabitants	24	236	50	185	214	22
Andalusia	20,000 - 50,000 inhabitants	44	103	28	75	85	18
Andalusia	< 20,000 inhabitants	675	16	6	11	12	4
Aragon	> 100,000 inhabitants	1	1,602	493	1,110	1,358	245
Aragon	50,000 - 100,000 inhabitants	1	306	47	259	217	89
Aragon	20,000 - 50,000 inhabitants	2	170	44	126	100	70
Aragon	< 20,000 inhabitants	726	6	2	3	4	2
Asturias	> 100,000 inhabitants	2	951	221	729	825	125
Asturias	50,000 - 100,000 inhabitants	2	201	66	135	168	33
Asturias	20,000 - 50,000 inhabitants	3	179	55	123	145	33
Asturias	< 20,000 inhabitants	71	23	14	8	15	8
The Canary Islands	> 100,000 inhabitants	4	908	237	670	809	99
The Canary Islands	50,000 - 100,000 inhabitants	4	260	78	182	218	42
The Canary Islands	20,000 - 50,000 inhabitants	19	87	46	42	70	18
The Canary Islands	< 20,000 inhabitants	61	26	17	9	14	12
Cantabria	> 100,000 inhabitants	1	662	119	543	518	144
Cantabria	50,000 - 100,000 inhabitants	1	207	49	158	168	40
Cantabria	20,000 - 50,000 inhabitants	3	95	21	74	79	16
Cantabria	< 20,000 inhabitants	97	12	5	7	9	3
Castile and Leon	> 100,000 inhabitants	4	708	148	561	578	130
Castile and Leon	50,000 - 100,000 inhabitants	5	324	82	242	282	42
Castile and Leon	20,000 - 50,000 inhabitants	6	98	21	77	77	21
Castile andLeon	< 20,000 inhabitants	2,232	6	3	4	4	2

(Continuation TABLE A-5)

ACs	STRATA	MUNICIPALITIES	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Castile-La Mancha	> 100,000 inhabitants	1	696	132	564	548	148
Castile-La Mancha	50,000 - 100,000 inhabitants	5	269	64	204	232	37
Castile-La Mancha	20,000 - 50,000 inhabitants	10	127	31	97	105	23
Castile-La Mancha	< 20,000 inhabitants	903	10	3	7	8	2
Catalonia	> 100,000 inhabitants	13	697	153	544	583	115
Catalonia	50,000 - 100,000 inhabitants	24	134	23	111	105	29
Catalonia	20,000 - 50,000 inhabitants	34	158	35	123	140	17
Catalonia	< 20,000 inhabitants	854	10	4	6	8	3
Valencian Community	> 100,000 inhabitants	4	2,584	633	1,951	2,224	360
Valencian Community	50,000 - 100,000 inhabitants	8	413	68	345	357	56
Valencian Community	20,000 - 50,000 inhabitants	30	141	38	103	126	15
Valencian Community	< 20,000 inhabitants	476	14	4	10	11	3
Extremadura	> 100,000 inhabitants	1	618	106	512	556	62
Extremadura	50,000 - 100,000 inhabitants	2	408	126	283	359	49
Extremadura	20,000 - 50,000 inhabitants	4	151	36	115	130	21
Extremadura	< 20,000 inhabitants	381	11	3	8	9	2
Galicia	> 100,000 inhabitants	4	746	141	606	650	97
Galicia	50,000 - 100,000 inhabitants	4	583	144	439	560	24
Galicia	20,000 - 50,000 inhabitants	15	143	33	110	126	17
Galicia	< 20,000 inhabitants	292	25	8	16	21	4
The Balearic Islands	> 100,000 inhabitants	1	704	190	513	568	135
The Balearic Islands	50,000 - 100,000 inhabitants	0	-	-	-	-	-
The Balearic Islands	20,000 - 50,000 inhabitants	11	96	32	63	71	25
The Balearic Islands	< 20,000 inhabitants	55	22	8	14	15	8

(Continuation TABLE A-5)

ACs	STRATA	MUNICIPALITIES	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Madrid	> 100,000 inhabitants	1	11,279	3,293	7,986	9,526	1,754
Madrid	50,000 - 100,000 inhabitants	0	-	-	-	-	-
Madrid	20,000 - 50,000 inhabitants	0	-	-	-	-	-
Madrid	< 20,000 inhabitants	0	-	-	-	-	-
Navarre	> 100,000 inhabitants	42	47	11	35	42	5
Navarre	50,000 - 100,000 inhabitants	0	-	-	-	-	-
Navarre	20,000 - 50,000 inhabitants	2	154	33	121	72	82
Navarre	< 20,000 inhabitants	228	8	3	5	7	2
The Basque Country	> 100,000 inhabitants	5	1.015	316	700	842	174
The Basque Country	50,000 - 100,000 inhabitants	3	379	62	316	323	56
The Basque Country	20,000 - 50,000 inhabitants	7	163	64	99	142	21
The Basque Country	< 20,000 inhabitants	169	17	7	10	14	3
Region of Murcia	> 100,000 inhabitants	9	517	116	401	466	51
Region of Murcia	50,000 - 100,000 inhabitants	2	604	155	449	493	111
Region of Murcia	20,000 - 50,000 inhabitants	8	175	40	136	151	25
Region of Murcia	< 20,000 inhabitants	26	34	11	23	28	6
La Rioja	> 100,000 inhabitants	1	612	94	517	517	94
La Rioja	50,000 - 100,000 inhabitants	0	-	-	-	-	-
La Rioja	20,000 - 50,000 inhabitants	1	104	21	83	53	50
La Rioja	< 20,000 inhabitants	172	4	2	2	3	1

Note: Metropolitan areas are included within municipalities with over 100,000 inhabitants to safeguard statistical confidentiality. Regarding metropolitan areas (which comprise several municipalities), the current value was obtained according to metropolitan area rather than to municipality.

Table A.6. Annual investment in renewing the entire inventory (expressed in millions of €) of the "standard municipality" for each stratum within each Autonomous Community. Baseline scenario results, achieved using the technical renewal period as per survey conducted among service providers

ACs	STRATA	MUNICIPALITIES	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Andalusia	> 100,000 inhabitants	24	9.88	1.89	7.98	7.89	1.99
Andalusia	50,000 - 100,000 inhabitants	24	3.72	0.78	2.94	3.14	0.57
Andalusia	20,000 - 50,000 inhabitants	44	2.92	0.44	2.48	2.40	0.53
Andalusia	< 20,000 inhabitants	675	0.28	0.10	0.18	0.18	0.10
Aragon	> 100,000 inhabitants	1	23.99	6.71	17.27	17.90	6.09
Aragon	50,000 - 100,000 inhabitants	1	6.13	0.73	5.39	3.06	3.06
Aragon	20,000 - 50,000 inhabitants	2	4.97	0.70	4.27	2.60	2.37
Aragon	< 20,000 inhabitants	726	0.10	0.04	0.05	0.06	0.04
Asturias	> 100,000 inhabitants	2	21.17	3.59	17.58	17.77	3.40
Asturias	50,000 - 100,000 inhabitants	2	3.16	0.89	2.27	2.28	0.87
Asturias	20,000 - 50,000 inhabitants	3	4.76	0.80	3.96	3.73	1.03
Asturias	< 20,000 inhabitants	71	0.40	0.26	0.14	0.24	0.16
The Canary Islands	> 100,000 inhabitants	4	17.41	4.11	13.30	15.01	2.40
The Canary Islands	50,000 - 100,000 inhabitants	4	4.60	1.25	3.35	3.53	1.07
The Canary Islands	20,000 - 50,000 inhabitants	19	1.97	0.75	1.23	1.54	0.43
The Canary Islands	< 20,000 inhabitants	61	0.54	0.30	0.24	0.22	0.32
Cantabria	> 100,000 inhabitants	1	12.90	1.81	11.09	8.32	4.58
Cantabria	50,000 - 100,000 inhabitants	1	3.84	0.79	3.05	2.58	1.26
Cantabria	20,000 - 50,000 inhabitants	3	2.69	0.38	2.31	2.21	0.48
Cantabria	< 20,000 inhabitants	97	0.21	0.09	0.12	0.14	0.07
Castile and Leon	> 100,000 inhabitants	4	14.51	2.17	12.33	10.80	3.71
Castile and Leon	50,000 - 100,000 inhabitants	5	4.77	1.10	3.67	3.78	0.98
Castile and Leon	20,000 - 50,000 inhabitants	6	2.84	0.31	2.53	2.16	0.68

(Continuation TABLE A-6)

ACs	STRATA	MUNICIPALITIES	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Castile and Leon	< 20,000 inhabitants	2.232	0.10	0.05	0.05	0.06	0.04
Castile-La Mancha	> 100,000 inhabitants	1	13.27	1.95	11.32	8.31	4.96
Castile-La Mancha	50,000 - 100,000 inhabitants	5	4.27	0.87	3.39	3.18	1.08
Castile-La Mancha	20,000 - 50,000 inhabitants	10	3.70	0.49	3.21	2.97	0.73
Castile-La Mancha	< 20,000 inhabitants	903	0.16	0.05	0.10	0.12	0.04
Catalonia	> 100,000 inhabitants	13	12.58	2.22	10.36	8.94	3.64
Catalonia	50,000 - 100,000 inhabitants	24	2.17	0.31	1.86	1.48	0.69
Catalonia	20,000 - 50,000 inhabitants	34	4.71	0.50	4.21	4.21	0.50
Catalonia	< 20,000 inhabitants	854	0.18	0.07	0.11	0.12	0.06
Valencian Community	> 100,000 inhabitants	4	45.39	9.66	35.73	35.42	9.97
Valencian Community	50,000 - 100,000 inhabitants	8	6.90	1.00	5.90	5.08	1.82
Valencian Community	20,000 - 50,000 inhabitants	30	3.94	0.57	3.36	3.48	0.45
Valencian Community	< 20,000 inhabitants	476	0.24	0.08	0.16	0.16	0.07
Extremadura	> 100,000 inhabitants	1	11.02	2.06	8.95	9.45	1.57
Extremadura	50,000 - 100,000 inhabitants	2	6.21	1.54	4.67	4.76	1.45
Extremadura	20,000 - 50,000 inhabitants	4	4.31	0.57	3.74	3.67	0.64
Extremadura	< 20,000 inhabitants	381	0.19	0.05	0.14	0.13	0.06
Galicia	> 100,000 inhabitants	4	14.42	2.05	12.37	11.62	2.80
Galicia	50,000 - 100,000 inhabitants	4	9.78	1.82	7.96	9.19	0.59
Galicia	20,000 - 50,000 inhabitants	15	3.78	0.50	3.28	3.23	0.55
Galicia	< 20,000 inhabitants	292	0.45	0.16	0.29	0.34	0.10
The Balearic Islands	> 100,000 inhabitants	1	17.43	3.21	14.22	13.06	4.37
The Balearic Islands	50,000 - 100,000 inhabitants	0	-	-	-	-	-
The Balearic Islands	20,000 - 50,000 inhabitants	11	2.60	0.52	2.08	1.84	0.76

(Continuation TABLE A-6)

ACs	STRATA	MUNICIPALITIES	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
The Balearic Islands	< 20,000 inhabitants	55	0.47	0.15	0.33	0.26	0.22
Madrid	> 100,000 inhabitants	1	182.27	40.99	141.28	134.40	47.87
Madrid	50,000 - 100,000 inhabitants	0	-	-	-	-	-
Madrid	20,000 - 50,000 inhabitants	0	-	-	-	-	-
Madrid	< 20,000 inhabitants	0	-	-	-	-	-
Navarre	> 100,000 inhabitants	42	0.85	0.16	0.69	0.73	0.12
Navarre	50,000 - 100,000 inhabitants	0	-	-	-	-	-
Navarre	20,000 - 50,000 inhabitants	2	4.03	0.42	3.61	1.59	2.44
Navarre	< 20,000 inhabitants	228	0.12	0.05	0.08	0.09	0.04
The Basque Country	> 100,000 inhabitants	5	16.52	4.43	12.09	12.67	3.85
The Basque Country	50,000 - 100,000 inhabitants	3	6.30	0.76	5.53	4.53	1.77
The Basque Country	20,000 - 50,000 inhabitants	7	3.92	0.78	3.14	3.26	0.65
The Basque Country	< 20,000 inhabitants	169	0.25	0.11	0.15	0.18	0.07
Region of Murcia	> 100,000 inhabitants	9	9.47	1.87	7.60	7.87	1.59
Region of Murcia	50,000 - 100,000 inhabitants	2	11.05	2.36	8.69	7.20	3.85
Region of Murcia	20,000 - 50,000 inhabitants	8	4.78	0.65	4.13	4.04	0.73
Region of Murcia	< 20,000 inhabitants	26	0.56	0.20	0.36	0.40	0.16
La Rioja	> 100,000 inhabitants	1	11.84	1.79	10.05	8.94	2.90
La Rioja	50,000 - 100,000 inhabitants	0	-	-	-	-	-
La Rioja	20,000 - 50,000 inhabitants	1	3.14	0.32	2.81	1.43	1.70
La Rioja	< 20,000 inhabitants	172	0.07	0.03	0.04	0.04	0.03

Note: Metropolitan areas are included within municipalities with over 100,000 inhabitants to safeguard statistical confidentiality Regarding metropolitan areas (which comprise several municipalities), the annual investment in renovation actions was obtained according to metropolitan area rather than to municipality.

Table A.7. Annual investment in renewing the entire inventory (expressed in millions of €) of the "standard municipality" for each stratum within each Autonomous Community. Baseline scenario results, achieved using the renewal period based on theoretical limits

ACs	STRATA	MUNICIPALITIES	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Andalusia	> 100,000 inhabitants	24	5.77	1.59	4.18	4.56	1.21
Andalusia	50,000 - 100,000 inhabitants	24	2.24	0.58	1.66	1.87	0.37
Andalusia	20,000 - 50,000 inhabitants	44	1.10	0.32	0.78	0.77	0.32
Andalusia	< 20,000 inhabitants	675	0.18	0.07	0.11	0.11	0.06
Aragon	> 100,000 inhabitants	1	16.78	5.98	10.80	12.77	4.01
Aragon	50,000 - 100,000 inhabitants	1	3.67	0.56	3.10	1.88	1.78
Aragon	20,000 - 50,000 inhabitants	2	2.30	0.50	1.80	0.91	1.38
Aragon	< 20,000 inhabitants	726	0.07	0.03	0.03	0.04	0.03
Asturias	> 100,000 inhabitants	2	10.44	2.67	7.77	8.28	2.16
Asturias	50,000 - 100,000 inhabitants	2	2.06	0.76	1.30	1.50	0.56
Asturias	20,000 - 50,000 inhabitants	3	1.93	0.62	1.31	1.31	0.62
Asturias	< 20,000 inhabitants	71	0.25	0.17	0.09	0.14	0.11
The Canary Islands	> 100,000 inhabitants	4	9.33	2.77	6.55	7.73	1.60
The Canary Islands	50,000 - 100,000 inhabitants	4	2.67	0.89	1.78	1.97	0.70
The Canary Islands	20,000 - 50,000 inhabitants	19	0.94	0.50	0.44	0.65	0.29
The Canary Islands	< 20,000 inhabitants	61	0.34	0.20	0.14	0.14	0.21
Cantabria	> 100,000 inhabitants	1	7.63	1.44	6.19	4.89	2.74
Cantabria	50,000 - 100,000 inhabitants	1	2.25	0.55	1.70	1.49	0.75
Cantabria	20,000 - 50,000 inhabitants	3	1.01	0.23	0.77	0.71	0.29
Cantabria	< 20,000 inhabitants	97	0.13	0.06	0.07	0.09	0.05
Castile and Leon	> 100,000 inhabitants	4	8.04	1.78	6.27	5.74	2.31
Castile and Leon	50,000 - 100,000 inhabitants	5	3.08	0.88	2.19	2.41	0.66
Castile and Leon	20,000 - 50,000 inhabitants	6	1.08	0.25	0.83	0.67	0.41

(Continuation TABLE A-7)

ACs	STRATA	MUNICIPALITIES	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
Castile and Leon	< 20,000 inhabitants	2.232	0.07	0.03	0.03	0.04	0.03
Castile-La Mancha	> 100,000 inhabitants	1	8.02	1.58	6.44	5.11	2.91
Castile-La Mancha	50,000 - 100,000 inhabitants	5	2.69	0.73	1.96	2.02	0.67
Castile-La Mancha	20,000 - 50,000 inhabitants	10	1.37	0.34	1.02	0.93	0.43
Castile-La Mancha	< 20,000 inhabitants	903	0.10	0.03	0.06	0.07	0.03
Catalonia	> 100,000 inhabitants	13	7.77	1.82	5.95	5.60	2.18
Catalonia	50,000 - 100,000 inhabitants	24	1.37	0.25	1.12	0.90	0.46
Catalonia	20,000 - 50,000 inhabitants	34	1.59	0.39	1.20	1.28	0.31
Catalonia	< 20,000 inhabitants	854	0.12	0.05	0.07	0.08	0.04
Valencian Community	> 100,000 inhabitants	4	28.29	7.74	20.55	22.01	6.28
Valencian Community	50,000 - 100,000 inhabitants	8	4.15	0.77	3.38	3.07	1.08
Valencian Community	20,000 - 50,000 inhabitants	30	1.39	0.42	0.97	1.11	0.28
Valencian Community	< 20,000 inhabitants	476	0.15	0.05	0.10	0.10	0.05
Extremadura	> 100,000 inhabitants	1	6.22	1.32	4.89	5.20	1.02
Extremadura	50,000 - 100,000 inhabitants	2	4.06	1.37	2.68	3.17	0.89
Extremadura	20,000 - 50,000 inhabitants	4	1.53	0.40	1.13	1.15	0.39
Extremadura	< 20,000 inhabitants	381	0.12	0.03	0.08	0.08	0.04
Galicia	> 100,000 inhabitants	4	7.98	1.67	6.32	6.25	1.73
Galicia	50,000 - 100,000 inhabitants	4	5.58	1.52	4.06	5.19	0.39
Galicia	20,000 - 50,000 inhabitants	15	1.47	0.33	1.14	1.15	0.32
Galicia	< 20,000 inhabitants	292	0.27	0.10	0.17	0.20	0.07
The Balearic Islands	> 100,000 inhabitants	1	9.28	2.43	6.85	6.69	2.59
The Balearic Islands	50,000 - 100,000 inhabitants	0	-	-	-	-	-
The Balearic Islands	20,000 - 50,000 inhabitants	11	1.12	0.38	0.75	0.66	0.46

(Continuation TABLE A-7)

ACs	STRATA	MUNICIPALITIES	TOTAL INVENTORY	WATER SUPPLY	SANITATION	NETWORKS	INFRASTRUCTURE
The Balearic Islands	< 20,000 inhabitants	55	0.29	0.10	0.19	0.16	0.14
Madrid	> 100,000 inhabitants	1	123.14	38.71	84.42	92.85	30.28
Madrid	50,000 - 100,000 inhabitants	0	-	-	-	-	-
Madrid	20,000 - 50,000 inhabitants	0	-	-	-	-	-
Madrid	< 20,000 inhabitants	0	-	-	-	-	-
Navarre	> 100,000 inhabitants	42	0.48	0.13	0.34	0.40	0.08
Navarre	50,000 - 100,000 inhabitants	0	-	-	-	-	-
Navarre	20,000 - 50,000 inhabitants	2	2.14	0.36	1.78	0.65	1.49
Navarre	< 20,000 inhabitants	228	0.09	0.04	0.05	0.06	0.03
The Basque Country	> 100,000 inhabitants	5	10.67	3.83	6.84	8.01	2.66
The Basque Country	50,000 - 100,000 inhabitants	3	3.82	0.66	3.16	2.76	1.06
The Basque Country	20,000 - 50,000 inhabitants	7	1.69	0.67	1.01	1.29	0.39
The Basque Country	< 20,000 inhabitants	169	0.18	0.08	0.09	0.13	0.05
Region of Murcia	> 100,000 inhabitants	9	5.47	1.41	4.06	4.51	0.96
Region of Murcia	50,000 - 100,000 inhabitants	2	6.60	1.65	4.95	4.38	2.23
Region of Murcia	20,000 - 50,000 inhabitants	8	1.79	0.47	1.32	1.34	0.45
Region of Murcia	< 20,000 inhabitants	26	0.35	0.13	0.22	0.25	0.10
La Rioja	> 100,000 inhabitants	1	6.60	1.15	5.45	4.85	1.75
La Rioja	50,000 - 100,000 inhabitants	0	-	-	-	-	-
La Rioja	20,000 - 50,000 inhabitants	1	1.49	0.25	1.24	0.49	1.00
La Rioja	< 20,000 inhabitants	172	0.05	0.02	0.02	0.02	0.02

Note: Metropolitan areas are included within municipalities with over 100,000 inhabitants to safeguard statistical confidentiality. Regarding metropolitan areas (which comprise several municipalities), the annual investment in renovation actions was obtained according to metropolitan area rather than to municipality.

APPENDIX B CLUSTERING

Table B.1. Distribution of clusters (expressed in %), broken down by Autonomous Community

WATER SUPPLY						
Cluster	**0**	**1**	**2**	**3**	**4**	**5**
TOTAL	**8.8**	**25.1**	**29.7**	**9.5**	**2.0**	**25.0**
Andalusia	13.3	12.9	45.8	20.7	0.3	7.1
Aragon	0.7	61.7	22.3	2.9	0.0	12.4
Asturias	9.0	0.0	46.2	39.7	0.0	5.1
The Canary Islands	34.5	0.0	0.0	25.5	40.0	0.0
Cantabria	4.9	2.9	47.1	25.5	1.0	18.6
Castile and Leon	0.3	26.0	31.8	2.5	0.4	38.9
Castile-La Mancha	1.7	17.4	11.8	7.5	2.5	59.1
Catalonia	10.1	29.3	29.3	9.0	7.8	14.3
Valencian Community	12.2	27.3	30.8	15.5	3.5	10.7
Extremadura	1.8	38.0	31.8	10.9	0.3	17.3
Galicia	7.3	4.2	39.0	30.0	0.0	19.5
The Balearic Islands	18.5	13.8	35.4	29.2	0.0	3.1
Madrid	100.0	0.0	0.0	0.0	0.0	0.0
Navarre	100.0	0.0	0.0	0.0	0.0	0.0
The Basque Country	100.0	0.0	0.0	0.0	0.0	0.0
Region of Murcia	42.2	11.1	6.7	40.0	0.0	0.0
La Rioja	1.1	14.9	77.6	5.2	0.0	1.1
SANEAMIENTO						
Cluster	**0**	**1**	**2**	**3**	**4**	**5**
TOTAL	**8.8**	**57.0**	**2.4**	**16.3**	**8.0**	**7.5**
Andalusia	13.2	36.3	1.3	28.0	4.0	17.2
Aragon	0.7	72.3	2.2	13.4	8.7	2.7
Asturias	9.0	5.1	2.6	62.8	0.0	20.5
The Canary Islands	41.3	0.0	2.2	32.6	4.3	19.6
Cantabria	4.9	23.5	4.9	52.0	5.9	8.8
Castile and Leon	0.3	74.1	0.9	11.6	11.9	1.3
Castile-La Mancha	1.7	77.1	0.2	10.7	2.6	7.6
Catalonia	10.0	44.9	11.5	8.7	17.6	7.3
Valencian Community	12.2	64.9	1.8	4.4	2.8	13.8
Extremadura	1.8	68.7	0.3	18.6	1.6	9.0
Galicia	7.4	8.3	0.0	52.9	7.1	24.4
The Balearic Islands	18.5	12.3	9.2	24.6	12.3	23.1
Madrid	100.0	0.0	0.0	0.0	0.0	0.0
Navarre	100.0	0.0	0.0	0.0	0.0	0.0
The Basque Country	100.0	0.0	0.0	0.0	0.0	0.0
Region of Murcia	42.2	13.3	0.0	8.9	2.2	33.3
La Rioja	1.1	42.5	0.0	54.0	0.0	2.3

APPENDIX C
PROJECTS, CATALOGUES OF WORKS AND NETWORK REGULATIONS CONSULTED

C.1. PROJECTS

Aguas de Burgos (2016) *(a municipal company)*. Documentación técnica del pliego para la rehabilitación de tubería de saneamiento y abastecimiento mediante tecnología sin zanja en obras de los proyectos de inversión de 2015-2016 *("Technical document for the specifications on the rehabilitation of water supply and sanitation pipelines, by means of trenchless technology for works under 2015-2016 investment projects").*

Ainsa–Sobrarbe Local Government (2014). Adenda de actualización de los proyectos de servicios para la urbanización de la U.A.-1 y la U.A.-2 del Polígono 12 de Ainsa (Huesca) *("Update addendum to the service projects for the development of U. of A. 1 & U. of A. 2 within Ainsa Industrial Estate 12 (Huesca)").*

Alcalá de Ebro Local Government (2015). Proyecto de actuaciones para reparar los daños producidos por la riada del Ebro en los caminos rurales de los municipios de Remolinos, Alcalá de Ebro y Cabañas de Ebro (Zona 2) *("Project encompassing the actions needed to repair the damage caused by Ebro river flooding processes on rural roads within the municipalities of Remolinos, Alcalá de Ebro and Cabañas de Ebro (Zone 2))".*

Alcalá de Henares Local Government (2013). Renovación de la red de abastecimiento calle Zaragoza. *("Renewal of Calle Zaragoza water supply network").*

Alcantarilla Local Government (2012). Proyecto de rehabilitación del entorno físico del Museo Etnológico de la Huerta de Murcia *(Rehabilitation project of the physical environment of the "Ethnological Museum of the irrigated lands of Murcia").*

Alfaro Local Government (2009). Proyecto básico y de ejecución: proyecto de adecuación de las redes de la plaza Planillo y calles anejas *("Basic implementation project: adaptation project of Planillo square and surrounding streets networks").*

Algar Local Government (2011). Reforma de infraestructuras y pavimentación en calle Guadalupe *("Calle Guadalupe Infrastructure and paving reform").*

Algeciras Local Government (2017). Proyecto de reordenación de las calles Pescadería, Teniente Maroto y avenida Virgen del Carmen entre Ojo del Muelle y Segismundo Moret *("Redevelopment project for Pescadería and Teniente Maroto streets and Virgen del Carmen; between Ojo del Muelle and Segismundo Moret").*

Alhama de Murcia (Local Government 2016). Proyecto de red de abastecimiento para el suministro de agua potable a la EDAR de la urbanización de Condado de Alhama *("Water supply network project to provide drinking water to the WWTP within Condado de Alhama urbanisation").*

Alhaurín de la Torre Local Government (2018). Reparación del camino de Moncayo, La Alquería, Alhaurín de la Torre, Málaga *(" Reparation of Moncayo path, La Alquería, Alhaurín de la Torre, Malaga").*

Provincial Deputation of Almería (2017). Plan de renovación de infraestructuras hidráulicas en Somontín *("Renewal plan for Somontín water infrastructure")*. Obra N.º 17PRIH2017 ("Work No.: 17PRIH2017).

Almoines Local Government (2016). PLA PCV 16-17: Repavimentació de Vials Almoines *("Vials Almoines Resurfacing").*

ANTIGUA OCAL GOVERNMENT (2013). Proyecto de acondicionamiento de plaza pública de Valles de Ortega *("Project for upgrading Valles de Ortega public square").*

ANTIGUA LOCAL GOVERNMENT (2016). Proyecto de ampliación de la capacidad del sistema de colectores de Aguas de Antigua *("Capacity expansion project for Antigua water collectors").* Fuerteventura Island.

ARANDA DE DUERO LOCAL GOVERNMENT (2017). Proyecto de reurbanización de las calles Moratín, Juan Padilla, Bravo y Maldonado (parcial) *("Redevelopment project for Moratín, Juan Padilla, Bravo and Maldonado streets (partial)").* Aranda de Duero, Burgos.

ARTAJONA LOCAL GOVERNMENT (2018). Actuación de restauración y creación de un espacio ambiental *("Restoration actions and environmental space creation").* South Lateral of Cerco de Artajona. Artajona–Navarre. Proyecto de Ejecución *("Implementation Project").*

ARTEA LOCAL GOVERNMENT (2015). Renovación de la red de abastecimiento de agua potable en la zona de Elexabeiti y Larrazabal *("Renewal of the drinking water supply network on the area of Elexabeiti y Larrazabal").*

ARUCAS (LOCAL GOVERNMENT 2017). Proyecto de repavimentación de la calle Marqueses de Arucas entre la calle Canarias y Antonio González *("Repaving project of Marqueses Arucas Streetbetween Canarias and Antonio González streets").*

AYORA LOCAL GOVERNMENT (2015). Proyecto de mejora de la red de saneamiento de la Calle Montemayor, Ayora *("Improvement project for Calle Montemayor sanitation network").*

AZUQUECA DE HENARES LOCAL GOVERNMENT (2009). Remodelación del parque de la Ermita, Azuqueca de Henares (Guadalajara) *("Redevelopment of Ermita park, Azuqueca de Henares (Guadalajara)").*

BECERRIL DE LA SIERRA LOCAL GOVERNMENT (2017). Proyecto de urbanización en Fuente de las Salineras, Becerril de la Sierra (Madrid) *("Development project in Fuente de las Salineras, Becerril de la Sierra (Madrid)").*

BENASQUE LOCAL GOVERNMENT (2012). Proyecto de reforma y refuerzo de la infraestructura primaria de abastecimiento de agua *("Water supply primary infrastructure reform and reinforcement project").* Benasque (Huesca).

Benavente Local Government (2015). Proyecto de urbanización del sector Surt-2 "Las Candelas", Avenida del Canal ("Development project for "Las Candelas" Surt-2 Sector", Canal Avenue"). Benavente, Zamora.

BERANGO LOCAL GOVERNMENT (2018). Renovación de abastecimiento y actuaciones complementarias de urbanización en el entorno del Caserío Arene Bidea 19 en Arene-AC27 *("Water supply renewal and development complementary actions in the vicinity of Caserío Arene Bidea 19 in Arene-AC27").* Berango (Bizkaia).

BURRIANA LOCAL GOVERNMENT (2011). Proyecto de urbanización U.E. D 1, 2 y 4-1 de Burriana *("U.E. D 1, 2 and 4-1 Development project in Burriana").*

CABAÑAS DE EBRO LOCAL GOVERNMENT (2015). Proyecto de actuaciones para reparar los daños producidos por la riada del Ebro en los caminos rurales de los municipios de Remolinos, Alcalá de Ebro y Cabañas de Ebro (Zona 2) *("Project encompassing the actions needed to repair the damage caused by Ebro river flooding processes on rural roads within the municipalities of Remolinos, Alcalá de Ebro and Cabañas de Ebro (Zone 2))".*

CÁDIZ LOCAL GOVERNMENT (2017). Proyecto de urbanización de los viales 5 y 13 del Plan Parcial de Ordenación de los sectores 001-AL y 002-AL del PGOU de San Roque (Cádiz) *("Development project for roads 5 and 13 within the Partial Management Plan for sectors 001-A and 002-of San Roque (Cádiz) Land-use planning").*

CASTELLÓN DE LA PLANA LOCAL GOVERNMENT (2016). Proyecto de colector de aguas residuales y pluviales en camino del Collet y asfaltado del mismo *("Rain and waste water collector project and paving of Collet path").*

Ciudad Real Local Government (2016). Proyecto de actuaciones para mejora de presiones en la red de abastecimiento de Valverde *("Project encompassing the actions needed to improve pressure in Valverde water supply network").*

Coín Local Government (2010). Proyecto de mejora de la red hídrica de la urbanización Las Palmeras (Fase 1) *("Las Palmeral urbanisation water supply improvement Project (Stage 1)").* Cóin (Malaga).

Consell Local Government (2015). Proyecto de sustitución de tubería de distribución de agua potable existente en la zona de San Togores *("Replacement project drinking water distribution pipelines existing in the area of San Togores").* Municipality of Consell, The Balearic Islands.

Córdoba Local Government (2016). Proyecto de remodelación de la avenida de la Fuensanta (Acerado Lonjas) y plaza Pelagio *("Fuensanta Avenue (Market steeling) and Pelagio Square remodelling project").* Córdoba Local Government.

Cox Local Government (2017). Proyecto técnico de renovación de la red de saneamiento de Cox en avenida del Carmen y calle Miguel Hernández *("Technical renewal project for Cox water supply network in Carmen Avenue and Miguel Hernandez street").*

El Villar de Arnedo Local Government (2008). Pavimentación y redes de servicios públicos en avenida de La Rioja de El Villar de Arnedo *("Paving and utility networks in La Rioja Avenue in El Villar de Arnedo").*

Elorrio Local Government (2012). Proyecto de urbanización de Vial y Puente del Ámbito A-8-7.7 *("Development project f or the Area A-8-7.7 road and bridge").* Ibarra-San Pio, Elorrio.

La Guancha Local Government (2016). Urbanización de la calle trasera a la Residencia Geriátrica y de la zona exterior de la futura piscina municipal *("Development of the Nursing Home back street and the exterior of the future municipal swimming pool").*

Huesca Local Government (2014a). Proyecto constructivo de sustitución de la red de saneamiento, reurbanización y supresión de barreras arquitectónicas en el Coso Alto de la ciudad de Huesca – Fase 1 *("Contruction project encompassing water supply replacement, redevelopment and elimination of Architectural barriers in Huesca Coso Alto - Stage 1").*

Huesca Local Government (2014b). Proyecto de sustitución de la red de saneamiento, urbanización y supresión de barreras arquitectónicas en la calle Ramiro el Monje, tramo Goya-Mozárabes *("Water supply replacement, development and elimination of Architectural barriers project in Ramiro el Monje Street, Goya-Mozárabes section").*

Huesca Local Government (2017a). Proyecto de obras de urbanización y construcción de 108 nichos en la primera fase de la ampliación del cementerio de Huesca *("Development and construction project for 108 niches during the first stage of the extension of Huesca Cemetery").*

Huesca Local Government (2017b). Proyecto de renovación de la red de saneamiento de la avenida Monegros, tramo comprendido entre la plaza Santa Clara y la Rotonda de la calle Teruel, Huesca *("Water supply network renewal project in project in Monegros Avenue, section between Santa Clara Square and Teruel Street roundabout, Huesca").*

Iznájar Local Government (2017). Reforma de la plaza de La Venta en Iznájar, Córdoba *("Alterations to La Venta Square in Iznázar, Córdoba").*

Jadrarque Local Government (2016). Renovación y reparación de las redes de saneamiento y abastecimiento en Jadrarque *("Renewal and repair of water supply and sanitation networks in Jadrarque").*

Jerez Local Government (2008). Proyecto de urbanización de la U.E. 4Q1 – El Portal *("U.E. 4Q1 – El Portal development project").*

Jerez Local Government (2009). Mejora de la red de saneamiento en la barriada El Portal *("Improvement of sanitation networks in El Portal neighbourhood").* Jerez de la Frontera.

Jerez Caballeros Local Government (2018). Sustitución de red de abastecimiento de agua en calle Toledillo Alto en Jeréz de los Caballeros y ejecución de saneamiento en calle Travesía Alcalá de Brovales (*"Water supply network replacement in Toledillo Alto Street in Jerez de los Caballeros and sanitation implementation in Travesía Alcalá de Brovales Street"*).

L'Eliana Local Government (2014). Proyecto de renovación de la tubería de abastecimiento de PVC bajo la rotonda de acceso a L'Eliana, Valencia (*"Renewal project for the PVC water supply pipeline under the access roundabout to L'Eliana, Valencia"*).

Laredo Local Government (2013). Renovación de las infraestructuras y pavimentación de la calle Merenillo de Laredo (*"Paving and infrastructure renewal in Merenillo de Laredo street"*).

Llanes Local Government (2017). Proyecto para la ejecución de red de saneamiento en la zona baja del barrio de la Concha (*"Implementation project for the sanitation network in La Concha lower neighbourhood"*).

Los Montesinos Local Government (2018). Proyecto básico de red de suministro de agua potable al polígono industrial de Los Montesinos (*"Drinking water supply network basic project in. Los Montesinos industrial estate"*).

Los Realejos Local Government (2016). Proyecto de mejora y pavimentación del camino de Las Vistas, tramo norte (desde cota 609 a cota 652) (*"Paving and improvement project for Las Vistas path, north section (from height 609 to height 652"*)).

Mieres Local Government (2013). Proyecto de mejora de los vials a Vegapiqueros (Figaredo) Mieres (*"Improvement period for Vegapiqueros roads (Figaredo), Mieres"*).

Mijas Local Government (2009). Proyecto de remodelación de Calle Virgen de Fátima en Las Lagunas, Mijas-Costa (*"Remodelling project for Virgen de Fátima street, in Las Lagunas, Mijas-Costa"*).

Motilla del Palancar Local Government (2016). City planning programme (P.A.U.,in its Spanish acronym). "Eras del Portillo" Proyecto de urbanización "Zona Z-16" (*"Eras del Portillo development project, Zone Z-16"*). Motilla del Palancar (Cuenca).

Navarrés Local Government (2010). Proyecto básico y de ejecución del casco histórico de Navarrés (*"Basic implementation project for Navarrés historic centre"*).

Oiartzun Local Government (2008). Proyecto de renovación sin zanja de tuberías de saneamiento en la calle Zuaznabar del polígono Ugaldetxo de Oiartzun (*"Trenchless renewal project for sanitation pipelines in Zuaznabar street within Ugaldetxo de Oiartzun industrial estate"*).

Orihuela Local Government (2009). Proyecto técnico de renovación de impulsión y colector de gravedad en la E.B.A.R. "Barranco Rubio" de la urbanización Campoamor de Orihuela, Alicante (*"Technical renewal project for Barranco Rubio WWPS pumping system and gravity collector within Campoamor de Orihuela urbanisation, Alicante"*).

Oropesa del Mar Local Government (2009). Proyecto de urbanización de la calle Albocasser (*"Albocasser street development project"*). Oropesa del Mar – Castellón.

Peñaranda de Bracamonte Local Government (2018). Proyecto de pavimentación y servicios de plaza España y Constitución (*"España y Constitución square paving and servicing project"*). Peñaranda de Bracamonte, Salamanca.

Peñíscola Local Government (2008). Proyecto de mejora del espacio público urbano e infraestructuras de las calles Playa y Río de Peñíscola (*"Improvement project for the urban public space and infrastructure in Playa and Río de Peñíscola streets"*).

Puente Genil Local Government (2016). Proyecto de cerramiento y urbanización interior de la segunda fase de ampliación del cementerio municipal de Puente Genil (Córdoba) (*"Closure and internal development project of the second expansion stage of Puente Genil municipal cemetery (Córdoba)"*).

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APPENDIX D
CONSTRUCTION UNITS PRICES

Table D.1. Construction units prices (in €), broken down by material, diameter and cluster

WATER SUPPLY						
MATERIAL	DIAMETER	CLUSTER	AVERAGE PRICE OF PIPING	AVERAGE PRICE OF CIVIL WORKS	AVERAGE PRICE OF PIECES	AVERAGE TOTAL PRICE
DUCTILE IRON	Small	1	22.62	51.29	5.93	79.84
DUCTILE IRON	Small	2	21.01	57.73	5.93	84.66
DUCTILE IRON	Small	3	23.96	45.93	5.93	75.82
DUCTILE IRON	Small	4	22.62	51.29	5.93	79.84
DUCTILE IRON	Small	5	22.62	51.29	5.93	79.84
DUCTILE IRON	Small	0	38.32	60.82	5.93	105.07
DUCTILE IRON	Medium	1	78.07	122.40	6.04	206.51
DUCTILE IRON	Medium	2	59.85	122.40	6.04	188.29
DUCTILE IRON	Medium	3	50.74	122.40	6.04	179.17
DUCTILE IRON	Medium	4	59.85	122.40	6.04	188.29
DUCTILE IRON	Medium	5	59.85	122.40	6.04	188.29
DUCTILE IRON	Medium	0	85.87	180.87	6.02	272.76
DUCTILE IRON	Large	1	235.36	470.72	11.77	706.08
DUCTILE IRON	Large	2	235.36	470.72	11.77	706.08
DUCTILE IRON	Large	3	235.36	470.72	11.77	706.08
DUCTILE IRON	Large	4	235.36	470.72	11.77	706.08
DUCTILE IRON	Large	5	235.36	470.72	11.77	706.08
DUCTILE IRON	Large	0	337.28	878.52	5.95	1,221.75
POLYETHYLENE	Small	1	4.79	25.31	5.93	36.04
POLYETHYLENE	Small	2	8.06	23.20	5.93	37.19
POLYETHYLENE	Small	3	1.98	17.33	5.93	25.24
POLYETHYLENE	Small	4	8.71	33.27	5.93	47.91
POLYETHYLENE	Small	5	6.41	27.64	5.93	39.98
POLYETHYLENE	Small	0	5.83	25.98	5.93	37.74
POLYETHYLENE	Medium	1	11.67	55.02	5.93	72.62
POLYETHYLENE	Medium	2	17.12	48.65	5.93	71.70
POLYETHYLENE	Medium	3	11.33	50.52	5.93	67.78
POLYETHYLENE	Medium	4	13.01	54.73	5.93	73.67
POLYETHYLENE	Medium	5	13.19	63.70	5.93	82.82
POLYETHYLENE	Medium	0	16.43	62.87	5.93	85.22
POLYETHYLENE	Large	1	48.13	178.65	6.02	232.80
POLYETHYLENE	Large	2	52.67	185.54	6.02	244.24
POLYETHYLENE	Large	3	65.04	202.33	6.02	273.39
POLYETHYLENE	Large	4	52.67	185.54	6.02	244.24
POLYETHYLENE	Large	5	38.30	169.65	6.03	213.98
POLYETHYLENE	Large	0	39.09	148.17	6.00	193.26

(Continuation TABLE D-1)

WATER SUPPLY						
MATERIAL	DIAMETER	CLUSTER	AVERAGE PRICE OF PIPING	AVERAGE PRICE OF CIVIL WORKS	AVERAGE PRICE OF PIECES	AVERAGE TOTAL PRICE
PVC	Small	1	20.89	37.09	5.93	63.91
PVC	Small	2	15.09	31.36	5.93	52.38
PVC	Small	3	17.99	34.23	8.70	60.92
PVC	Small	4	17.99	34.23	8.70	60.92
PVC	Small	5	17.99	34.23	8.70	60.92
PVC	Small	0	8.34	31.70	5.93	45.97
PVC	Medium	1	22.63	65.59	5.93	94.14
PVC	Medium	2	22.63	65.59	9.40	97.61
PVC	Medium	3	22.63	65.59	9.40	97.61
PVC	Medium	4	22.63	65.59	9.40	97.61
PVC	Medium	5	22.63	65.59	9.40	97.61
PVC	Medium	0	8.78	44.85	5.93	59.55
PVC	Large	1	113.47	356.40	23.07	492.94
PVC	Large	2	113.47	356.40	5.97	475.84
PVC	Large	3	113.47	356.40	23.07	492.94
PVC	Large	4	113.47	356.40	23.07	492.94
PVC	Large	5	113.47	356.40	23.07	492.94
PVC	Large	0	79.08	395.40	63.26	395.40
FIBRE CEMENT	Small	1	8.49	16.97	4.24	25.46
FIBRE CEMENT	Small	2	8.49	16.97	4.24	25.46
FIBRE CEMENT	Small	3	8.49	16.97	4.24	25.46
FIBRE CEMENT	Small	4	8.49	16.97	4.24	25.46
FIBRE CEMENT	Small	5	8.49	16.97	4.24	25.46
FIBRE CEMENT	Small	0	8.49	16.97	4.24	25.46
FIBRE CEMENT	Medium	1	17.98	35.97	8.99	53.95
FIBRE CEMENT	Medium	2	17.98	35.97	8.99	53.95
FIBRE CEMENT	Medium	3	17.98	35.97	8.99	53.95
FIBRE CEMENT	Medium	4	17.98	35.97	8.99	53.95
FIBRE CEMENT	Medium	5	17.98	35.97	8.99	53.95
FIBRE CEMENT	Medium	0	17.98	35.97	8.99	53.95
FIBRE CEMENT	Large	1	84.99	169.98	42.49	254.96
FIBRE CEMENT	Large	2	84.99	169.98	42.49	254.96
FIBRE CEMENT	Large	3	84.99	169.98	42.49	254.96
FIBRE CEMENT	Large	4	84.99	169.98	42.49	254.96
FIBRE CEMENT	Large	5	84.99	169.98	42.49	254.96
FIBRE CEMENT	Large	0	84.99	169.98	42.49	254.96
CONCRETE	Small	1	31.62	31.62	15.81	63.24
CONCRETE	Small	2	31.62	31.62	15.81	63.24
CONCRETE	Small	3	31.62	31.62	15.81	63.24
CONCRETE	Small	4	31.62	31.62	15.81	63.24

(Continuation TABLE D-1)

WATER SUPPLY						
MATERIAL	DIAMETER	CLUSTER	AVERAGE PRICE OF PIPING	AVERAGE PRICE OF CIVIL WORKS	AVERAGE PRICE OF PIECES	AVERAGE TOTAL PRICE
CONCRETE	Small	5	31.62	31.62	15.81	63.24
CONCRETE	Small	0	36.65	24.32	5.93	66.90
CONCRETE	Medium	1	72.29	72.29	36.14	144.58
CONCRETE	Medium	2	72.29	72.29	36.14	144.58
CONCRETE	Medium	3	72.29	72.29	36.14	144.58
CONCRETE	Medium	4	72.29	72.29	36.14	144.58
CONCRETE	Medium	5	72.29	72.29	36.14	144.58
CONCRETE	Medium	0	72.29	36.14	10.84	108.43
CONCRETE	Large	1	236.86	236.86	118.43	473.72
CONCRETE	Large	2	236.86	236.86	118.43	473.72
CONCRETE	Large	3	236.86	236.86	118.43	473.72
CONCRETE	Large	4	236.86	236.86	118.43	473.72
CONCRETE	Large	5	236.86	236.86	118.43	473.72
CONCRETE	Large	0	236.86	94.74	35.53	355.29
SANITATION						
MATERIAL	DIAMETER	CLUSTER	AVERAGE PRICE OF PIPING	AVERAGE PRICE OF CIVIL WORKS	AVERAGE PRICE OF PIECES	AVERAGE TOTAL PRICE
DUCTILE IRON	Small	1	27.51	50.40	4.12	82.03
DUCTILE IRON	Small	2	27.51	50.40	4.12	82.03
DUCTILE IRON	Small	3	27.51	50.40	4.12	82.03
DUCTILE IRON	Small	4	27.51	50.40	4.12	82.03
DUCTILE IRON	Small	5	27.51	50.40	4.12	82.03
DUCTILE IRON	Small	0	55.50	102.53	6.92	164.94
DUCTILE IRON	Medium	1	121.16	181.74	12.12	302.90
DUCTILE IRON	Medium	2	121.16	181.74	12.12	302.90
DUCTILE IRON	Medium	3	121.16	181.74	12.12	302.90
DUCTILE IRON	Medium	4	121.16	181.74	12.12	302.90
DUCTILE IRON	Medium	5	121.16	181.74	12.12	302.90
DUCTILE IRON	Medium	0	124.85	259.28	13.86	397.99
DUCTILE IRON	Large	1	180.33	225.41	9.02	360.66
DUCTILE IRON	Large	2	180.33	225.41	9.02	360.66
DUCTILE IRON	Large	3	180.33	225.41	9.02	360.66
DUCTILE IRON	Large	4	180.33	225.41	9.02	360.66
DUCTILE IRON	Large	5	180.33	225.41	9.02	360.66
DUCTILE IRON	Large	0	168.74	433.65	18.25	620.64
POLYETHYLENE	Small	1	18.43	131.14	3.22	152.79
POLYETHYLENE	Small	2	12.08	122.40	2.58	137.06
POLYETHYLENE	Small	3	17.37	129.68	3.11	150.17
POLYETHYLENE	Small	4	17.37	129.68	3.11	150.17
POLYETHYLENE	Small	5	17.37	129.68	3.11	150.17

(Continuation TABLE D-1)

SANITATION						
MATERIAL	DIAMETER	CLUSTER	AVERAGE PRICE OF PIPING	AVERAGE PRICE OF CIVIL WORKS	AVERAGE PRICE OF PIECES	AVERAGE TOTAL PRICE
POLYETHYLENE	Small	0	46.88	93.77	7.03	93.77
POLYETHYLENE	Medium	1	28.69	356.40	4.24	389.33
POLYETHYLENE	Medium	2	46.55	356.40	6.03	408.98
POLYETHYLENE	Medium	3	37.62	356.40	5.13	399.15
POLYETHYLENE	Medium	4	37.62	356.40	5.13	399.15
POLYETHYLENE	Medium	5	37.62	356.40	5.13	399.15
POLYETHYLENE	Medium	0	23.93	356.40	3.77	384.10
POLYETHYLENE	Large	1	254.58	509.16	25.46	509.16
POLYETHYLENE	Large	2	254.58	509.16	25.46	509.16
POLYETHYLENE	Large	3	254.58	509.16	25.46	509.16
POLYETHYLENE	Large	4	254.58	509.16	25.46	509.16
POLYETHYLENE	Large	5	254.58	509.16	25.46	509.16
POLYETHYLENE	Large	0	254.58	509.16	38.19	509.16
PVC	Small	1	19.00	99.41	3.27	121.68
PVC	Small	2	5.17	90.00	1.89	97.06
PVC	Small	3	21.21	122.40	3.49	147.11
PVC	Small	4	19.87	82.65	3.36	105.88
PVC	Small	5	24.26	114.30	3.80	142.35
PVC	Small	0	14.96	101.86	2.87	119.69
PVC	Medium	1	42.95	270.44	5.67	319.05
PVC	Medium	2	44.54	260.18	5.83	310.55
PVC	Medium	3	62.65	249.20	7.64	319.49
PVC	Medium	4	25.20	236.33	3.89	265.42
PVC	Medium	5	42.24	260.51	5.60	308.34
PVC	Medium	0	49.78	282.40	6.35	338.53
PVC	Large	1	295.52	1,245.55	30.98	1,572.05
PVC	Large	2	184.81	838.88	19.88	1,043.58
PVC	Large	3	229.76	773.85	24.40	1,028.01
PVC	Large	4	184.81	838.88	19.88	1,043.58
PVC	Large	5	109.40	607.89	12.32	729.61
PVC	Large	0	99.63	582.32	11.34	693.29
FIBRE CEMENT	Small	1	11.01	22.02	5.51	33.03
FIBRE CEMENT	Small	2	11.01	22.02	5.51	33.03
FIBRE CEMENT	Small	3	11.01	22.02	5.51	33.03
FIBRE CEMENT	Small	4	11.01	22.02	5.51	33.03
FIBRE CEMENT	Small	5	11.01	22.02	5.51	33.03
FIBRE CEMENT	Small	0	11.01	22.02	5.51	22.02
FIBRE CEMENT	Medium	1	56.66	113.33	28.33	113.33
FIBRE CEMENT	Medium	2	56.66	113.33	28.33	113.33
FIBRE CEMENT	Medium	3	56.66	113.33	28.33	113.33

(Continuation TABLE D-1)

SANITATION						
MATERIAL	DIAMETER	CLUSTER	AVERAGE PRICE OF PIPING	AVERAGE PRICE OF CIVIL WORKS	AVERAGE PRICE OF PIECES	AVERAGE TOTAL PRICE
FIBRE CEMENT	Medium	4	56.66	113.33	28.33	113.33
FIBRE CEMENT	Medium	5	56.66	113.33	28.33	113.33
FIBRE CEMENT	Medium	0	56.66	113.33	28.33	113.33
FIBRE CEMENT	Large	1	163.84	327.67	81.92	327.67
FIBRE CEMENT	Large	2	163.84	327.67	81.92	327.67
FIBRE CEMENT	Large	3	163.84	327.67	81.92	327.67
FIBRE CEMENT	Large	4	163.84	327.67	81.92	327.67
FIBRE CEMENT	Large	5	163.84	327.67	81.92	327.67
FIBRE CEMENT	Large	0	163.84	327.67	81.92	327.67
CONCRETE	Small	1	95.04	710.40	10.88	816.32
CONCRETE	Small	2	80.59	588.90	9.43	678.92
CONCRETE	Small	3	80.59	588.90	9.43	678.92
CONCRETE	Small	4	80.59	588.90	9.43	678.92
CONCRETE	Small	5	66.13	467.40	7.99	541.52
CONCRETE	Small	0	113.59	475.45	12.73	601.77
CONCRETE	Medium	1	119.26	1,184.40	13.35	1,317.01
CONCRETE	Medium	2	119.26	1,184.40	13.35	1,317.01
CONCRETE	Medium	3	110.56	1,184.40	12.48	1,307.44
CONCRETE	Medium	4	119.26	1,184.40	13.35	1,317.01
CONCRETE	Medium	5	127.95	1,184.40	14.22	1,326.57
CONCRETE	Medium	0	385.10	1,755.75	39.94	2,180.79
CONCRETE	Large	1	455.98	1,367.95	4.56	1,367.95
CONCRETE	Large	2	455.98	1,367.95	4.56	1,367.95
CONCRETE	Large	3	455.98	1,367.95	4.56	1,367.95
CONCRETE	Large	4	455.98	1,367.95	4.56	1,367.95
CONCRETE	Large	5	455.98	1,367.95	4.56	1,367.95
CONCRETE	Large	0	938.64	5,073.69	95.29	6,107.61

Table D.2. Construction units prices (expressed in €), broken down by material, diameter, Autonomous Community and stratum (subsets of population)

WATER SUPPLY CONSTRUCTION UNITS PRICE, BROKEN DOWN BY AUTONOMOUS COMMUNITY AND STRATUM																			
STRATUM	MATERIAL	DIAMETER	Andalusia	Aragon	Asturias	The Canary Islands	Cantabria	Castile and Leon	Castile-La Mancha	Catalonia	Valencian Community	Extremadura	Galicia	The Balearic Islands	Madrid	Navarre	The Basque Country	Region of Murcia	La Rioja	National
5-8	DUCTILE IRON	Small	79.22	79.82	77.63	77.46	79.94	80.69	79.03	79.29	78.44	79.65	78.78	77.76	78.97	78.97	78.97	76.21	81.71	79.21
5-8	DUCTILE IRON	Medium	184.86	196.88	181.16	182.89	184.46	191.03	187.40	187.78	186.57	191.46	183.80	183.14	186.53	186.53	186.53	180.66	189.35	187.02
5-8	DUCTILE IRON	Large	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08	706.08
5-8	POLYETHYLENE	Small	30.79	34.30	27.91	34.48	31.97	36.34	34.53	33.26	30.55	33.35	30.80	28.38	31.92	31.92	31.92	26.02	34.18	32.54
5-8	POLYETHYLENE	Medium	70.26	72.14	68.91	70.18	71.12	75.23	75.44	71.62	70.35	72.08	71.14	69.00	71.18	71.18	71.18	68.10	70.98	72.01
5-8	POLYETHYLENE	Large	257.44	241.65	266.29	261.51	254.18	235.25	239.15	250.86	256.71	246.15	255.89	264.37	253.52	253.52	253.52	270.82	248.99	250.23
5-8	PVC	Small	58.42	61.24	59.27	60.92	57.52	59.09	60.38	59.52	59.95	59.99	58.88	59.65	59.44	59.44	59.44	60.86	56.46	59.39
5-8	PVC	Medium	97.32	95.63	97.61	97.61	97.54	96.85	97.21	97.00	96.96	96.45	97.48	97.32	97.10	97.10	97.10	97.45	97.00	97.10
5-8	PVC	Large	487.45	490.16	489.64	492.94	486.00	487.97	491.17	489.07	489.89	489.08	488.64	489.90	489.10	489.10	489.10	492.55	482.95	489.00
5-8	FIBRE CEMENT	Small	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46
5-8	FIBRE CEMENT	Medium	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95
5-8	FIBRE CEMENT	Large	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96
5-8	CONCRETE	Small	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24	63.24
5-8	CONCRETE	Medium	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58	144.58
5-8	CONCRETE	Large	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72	473.72
5-8	OTHERS	Small	51.42	52.81	50.70	52.31	51.62	52.96	52.53	52.15	51.53	52.34	51.43	50.90	51.81	51.81	51.81	50.36	52.21	51.97
5-8	OTHERS	Medium	110.19	112.63	109.24	109.84	110.33	112.33	111.72	110.99	110.48	111.70	110.19	109.60	110.67	110.67	110.67	108.95	111.17	110.93
5-8	OTHERS	Large	435.93	433.31	438.14	437.84	434.99	431.60	433.02	434.94	436.27	434.00	435.86	437.81	435.48	435.48	435.48	439.63	433.34	434.80
4	DUCTILE IRON	Small	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07
4	DUCTILE IRON	Medium	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76
4	DUCTILE IRON	Large	1,221.75	1,221.75	1,221.75	1221.75	1,221.75	1221.75	1,221.75	1,221.75	1221.75	1,221.75	1,221.75	1221.75	1221.75	1221.75	1221.75	1221.75	1,221.75	1221.75
4	POLYETHYLENE	Small	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74
4	POLYETHYLENE	Medium	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22
4	POLYETHYLENE	Large	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26
4	PVC	Small	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97
4	PVC	Medium	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55
4	PVC	Large	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40
4	FIBRE CEMENT	Small	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46
4	FIBRE CEMENT	Medium	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95
4	FIBRE CEMENT	Large	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96
4	CONCRETE	Small	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90
4	CONCRETE	Medium	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43

(Continuation TABLE D.2.)

WATER SUPPLY CONSTRUCTION UNITS PRICE, BROKEN DOWN BY AUTONOMOUS COMMUNITY AND STRATUM																				
STRATUM	MATERIAL	DIAMETER	Andalusia	Aragon	Asturias	The Canary Islands	Cantabria	Castile and Leon	Castile-La Mancha	Catalonia	Valencian Community	Extremadura	Galicia	The Balearic Islands	Madrid	Navarre	The Basque Country	Region of Murcia	La Rioja	National
4	CONCRETE	Large	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29
4	OTHERS	Small	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23
4	OTHERS	Medium	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98
4	OTHERS	Large	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13
3	DUCTILE IRON	Small	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07
3	DUCTILE IRON	Medium	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76
3	DUCTILE IRON	Large	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1221.75	1,221.75	1,221.75
3	POLYETHYLENE	Small	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74
3	POLYETHYLENE	Medium	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22
3	POLYETHYLENE	Large	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26
3	PVC	Small	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97
3	PVC	Medium	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55
3	PVC	Large	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40
3	FIBRE CEMENT	Small	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46
3	FIBRE CEMENT	Medium	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95
3	FIBRE CEMENT	Large	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96
3	CONCRETE	Small	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90
3	CONCRETE	Medium	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43
3	CONCRETE	Large	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29
3	OTHERS	Small	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23
3	OTHERS	Medium	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98
3	OTHERS	Large	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13
2	DUCTILE IRON	Small	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07
2	DUCTILE IRON	Medium	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76
2	DUCTILE IRON	Large	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1221.75	1,221.75	1,221.75
2	POLYETHYLENE	Small	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74
2	POLYETHYLENE	Medium	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22
2	POLYETHYLENE	Large	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26
2	PVC	Small	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97
2	PVC	Medium	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55
2	PVC	Large	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40
2	FIBRE CEMENT	Small	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46

(Continuation TABLE D.2.)

WATER SUPPLY CONSTRUCTION UNITS PRICE, BROKEN DOWN BY AUTONOMOUS COMMUNITY AND STRATUM																				
STRATUM	MATERIAL	DIAMETER	Andalusia	Aragon	Asturias	The Canary Islands	Cantabria	Castile and Leon	Castile-La Mancha	Catalonia	Valencian Community	Extremadura	Galicia	The Balearic Islands	Madrid	Navarre	The Basque Country	Region of Murcia	La Rioja	National
2	FIBRE CEMENT	Medium	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95
2	FIBRE CEMENT	Large	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96
2	CONCRETE	Small	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90
2	CONCRETE	Medium	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43
2	CONCRETE	Large	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29
2	OTHERS	Small	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23
2	OTHERS	Medium	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98
2	OTHERS	Large	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13
1	DUCTILE IRON	Small	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07	105.07
1	DUCTILE IRON	Medium	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76	272.76
1	DUCTILE IRON	Large	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75	1221.75	1,221.75	1,221.75	1,221.75	1,221.75	1,221.75
1	POLYETHYLENE	Small	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74
1	POLYETHYLENE	Medium	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22	85.22
1	POLYETHYLENE	Large	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26	193.26
1	PVC	Small	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97	45.97
1	PVC	Medium	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55	59.55
1	PVC	Large	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40	395.40
1	FIBRE CEMENT	Small	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46
1	FIBRE CEMENT	Medium	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95	53.95
1	FIBRE CEMENT	Large	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96	254.96
1	CONCRETE	Small	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90	66.90
1	CONCRETE	Medium	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43
1	CONCRETE	Large	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29	355.29
1	OTHERS	Small	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23	56.23
1	OTHERS	Medium	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98	115.98
1	OTHERS	Large	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13	484.13

(Continuation TABLE D.2.)

SANITATION CONSTRUCTION UNITS PRICE BROKEN DOWN BY AUTONOMOUS COMMUNITY AND STRATUM																				
STRATUM	MATERIAL	DIAMETER	Andalusia	Aragon	Asturias	The Canary Islands	Cantabria	Castile and Leon	Castile-La Mancha	Catalonia	Valencian Community	Extremadura	Galicia	The Balearic Islands	Madrid	Navarre	The Basque Country	Region of Murcia	La Rioja	National
5-8	DUCTILE IRON	Small	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03	82.03
5-8	DUCTILE IRON	Medium	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90	302.90
5-8	DUCTILE IRON	Large	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66	360.66
5-8	POLYETHYLENE	Small	146.17	149.53	147.63	150.17	144.90	146.93	149.11	147.67	148.32	148.09	146.96	148.05	147.61	147.61	147.61	149.99	142.97	147.53
5-8	POLYETHYLENE	Medium	401.50	395.13	401.05	399.15	402.93	399.86	399.04	399.64	399.07	398.09	401.27	400.08	399.92	399.92	399.92	398.92	403.17	399.97
5-8	POLYETHYLENE	Large	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16
5-8	PVC	Small	128.63	124.10	137.32	130.31	125.66	125.06	136.32	127.48	132.61	126.64	132.89	136.05	130.08	130.08	130.08	144.77	113.35	130.07
5-8	PVC	Medium	315.93	317.08	317.49	297.46	314.54	312.55	312.84	311.85	316.46	315.85	315.59	317.78	314.20	314.20	314.20	319.26	314.15	314.25
5-8	PVC	Large	1,061.96	1,322.95	1,023.71	1,034.36	1,013.44	1,048.32	961.31	1,096.51	1115.17	1,178.04	1,008.20	1,073.89	1,080.27	1,080.27	1,080.27	1,053.89	1,132.00	1,063.13
5-8	FIBRE CEMENT	Small	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03	33.03
5-8	FIBRE CEMENT	Medium	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33
5-8	FIBRE CEMENT	Large	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67
5-8	CONCRETE	Small	682.88	748.83	675.55	678.92	666.89	661.38	634.32	688.29	696.52	708.58	663.86	689.34	684.53	684.53	684.53	685.36	702.67	676.59
5-8	CONCRETE	Medium	1,312.35	1,315.69	1,309.76	1,311.34	1,313.63	1,319.01	1,318.08	1314.13	1,312.19	1,315.08	1,312.99	1,310.09	1313.37	1,313.37	1,313.37	1,308.11	1,314.78	1,314.43
5-8	CONCRETE	Large	1,367.95	1,367.95	1,367.95	1,367.95	1,367.95	1,367.95	1,367.95	1,367.95	1,367.95	1,367.95	1,367.95	1,367.95	1367.95	1,367.95	1,367.95	1,367.95	1,367.95	1,367.95
5-8	OTHERS	Small	214.55	227.51	215.11	214.89	210.50	209.69	206.96	215.70	218.50	219.67	211.76	217.70	215.46	215.46	215.46	219.04	214.81	213.85
5-8	OTHERS	Medium	489.20	488.82	488.90	484.84	489.46	489.53	489.24	488.37	488.79	489.05	489.22	488.83	488.74	488.74	488.74	488.50	489.66	488.97
5-8	OTHERS	Large	725.48	777.68	717.83	719.96	715.78	722.75	705.35	732.39	736.12	748.70	714.73	727.87	729.14	729.14	729.14	723.87	739.49	725.71
4	DUCTILE IRON	Small	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	105.07	105.07	105.07	164.94	164.94	164.94
4	DUCTILE IRON	Medium	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	272.76	272.76	272.76	397.99	397.99	397.99
4	DUCTILE IRON	Large	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	1221.75	1221.75	1221.75	620.64	620.64	620.64
4	POLYETHYLENE	Small	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	37.74	37.74	37.74	93.77	93.77	93.77
4	POLYETHYLENE	Medium	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	85.22	85.22	85.22	384.10	384.10	384.10
4	POLYETHYLENE	Large	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	193.26	193.26	193.26	509.16	509.16	509.16
4	PVC	Small	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	45.97	45.97	45.97	119.69	119.69	119.69
4	PVC	Medium	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	59.55	59.55	59.55	338.53	338.53	338.53
4	PVC	Large	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	395.40	395.40	395.40	693.29	693.29	693.29
4	FIBRE CEMENT	Small	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	25.46	25.46	25.46	22.02	22.02	22.02
4	FIBRE CEMENT	Medium	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	53.95	53.95	53.95	113.33	113.33	113.33
4	FIBRE CEMENT	Large	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	254.96	254.96	254.96	327.67	327.67	327.67
4	CONCRETE	Small	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	66.90	66.90	66.90	601.77	601.77	601.77
4	CONCRETE	Medium	2,180.79	2,180.79	2,180.79	2, 180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	108.43	108.43	108.43	2,180.79	2,180.79	2,180.79

(Continuation TABLE D.2.)

SANITATION CONSTRUCTION UNITS PRICE BROKEN DOWN BY AUTONOMOUS COMMUNITY AND STRATUM																				
STRATUM	MATERIAL	DIAMETER	Andalusia	Aragon	Asturias	The Canary Islands	Cantabria	Castile and Leon	Castile-La Mancha	Catalonia	Valencian Community	Extremadura	Galicia	The Balearic Islands	Madrid	Navarre	The Basque Country	Region of Murcia	La Rioja	National
4	CONCRETE	Large	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	355.29	355.29	355.29	6,107.61	6,107.61	6,107.61
4	OTHERS	Small	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	56.23	56.23	56.23	200.44	200.44	200.44
4	OTHERS	Medium	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	115.98	115.98	115.98	682.94	682.94	682.94
4	OTHERS	Large	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1651.67	1,651.67	1,651.67	1,651.67	484.13	484.13	484.13	1,651.67	1,651.67	1,651.67
3	DUCTILE IRON	Small	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	105.07	105.07	105.07	164.94	164.94	164.94
3	DUCTILE IRON	Medium	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	272.76	272.76	272.76	397.99	397.99	397.99
3	DUCTILE IRON	Large	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	1,221.75	1,221.75	1,221.75	620.64	620.64	620.64
3	POLYETHYLENE	Small	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	37.74	37.74	37.74	93.77	93.77	93.77
3	POLYETHYLENE	Medium	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	85.22	85.22	85.22	384.10	384.10	384.10
3	POLYETHYLENE	Large	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	193.26	193.26	193.26	509.16	509.16	509.16
3	PVC	Small	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	45.97	45.97	45.97	119.69	119.69	119.69
3	PVC	Medium	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	59.55	59.55	59.55	338.53	338.53	338.53
3	PVC	Large	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	395.40	395.40	395.40	693.29	693.29	693.29
3	FIBRE CEMENT	Small	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	25.46	25.46	25.46	22.02	22.02	22.02
3	FIBRE CEMENT	Medium	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	53.95	53.95	53.95	113.33	113.33	113.33
3	FIBRE CEMENT	Large	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	254.96	254.96	254.96	327.67	327.67	327.67
3	CONCRETE	Small	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	66.90	66.90	66.90	601.77	601.77	601.77
3	CONCRETE	Medium	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	108.43	108.43	108.43	2,180.79	2,180.79	2,180.79
3	CONCRETE	Large	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	355.29	355.29	355.29	6107.61	6,107.61	6,107.61
3	OTHERS	Small	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	56.23	56.23	56.23	200.44	200.44	200.44
3	OTHERS	Medium	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	115.98	115.98	115.98	682.94	682.94	682.94
3	OTHERS	Large	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	484.13	484.13	484.13	1651.67	1651.67	1,651.67
2	DUCTILE IRON	Small	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	105.07	105.07	105.07	164.94	164.94	164.94
2	DUCTILE IRON	Medium	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	272.76	272.76	272.76	397.99	397.99	397.99
2	DUCTILE IRON	Large	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	1,221.75	1,221.75	1,221.75	620.64	620.64	620.64
2	POLYETHYLENE	Small	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	37.74	37.74	37.74	93.77	93.77	93.77
2	POLYETHYLENE	Medium	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	85.22	85.22	85.22	384.10	384.10	384.10
2	POLYETHYLENE	Large	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	193.26	193.26	193.26	509.16	509.16	509.16
2	PVC	Small	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	45.97	45.97	45.97	119.69	119.69	119.69
2	PVC	Medium	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	59.55	59.55	59.55	338.53	338.53	338.53
2	PVC	Large	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	395.40	395.40	395.40	693.29	693.29	693.29
2	FIBRE CEMENT	Small	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	25.46	25.46	25.46	22.02	22.02	22.02

(Continuation TABLE D.2.)

SANITATION CONSTRUCTION UNITS PRICE BROKEN DOWN BY AUTONOMOUS COMMUNITY AND STRATUM																				
STRATUM	MATERIAL	DIAMETER	Andalusia	Aragon	Asturias	The Canary Islands	Cantabria	Castile and Leon	Castile-La Mancha	Catalonia	Valencian Community	Extremadura	Galicia	The Balearic Islands	Madrid	Navarre	The Basque Country	Region of Murcia	La Rioja	National
2	FIBRE CEMENT	Medium	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	53.95	53.95	53.95	113.33	113.33	113.33
2	FIBRE CEMENT	Large	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	254.96	254.96	254.96	327.67	327.67	327.67
2	CONCRETE	Small	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	66.90	66.90	66.90	601.77	601.77	601.77
2	CONCRETE	Medium	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	108.43	108.43	108.43	2,180.79	2,180.79	2,180.79
2	CONCRETE	Large	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	355.29	355.29	355.29	6,107.61	6,107.61	6,107.61
2	OTHERS	Small	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	56.23	56.23	56.23	200.44	200.44	200.44
2	OTHERS	Medium	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	115.98	115.98	115.98	682.94	682.94	682.94
2	OTHERS	Large	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	484.13	484.13	484.13	1,651.67	1,651.67	1,651.67
1	DUCTILE IRON	Small	1,64.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	164.94	105.07	105.07	105.07	164.94	164.94	164.94
1	DUCTILE IRON	Medium	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	397.99	272.76	272.76	272.76	397.99	397.99	397.99
1	DUCTILE IRON	Large	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	620.64	1,221.75	1,221.75	1,221.75	620.64	620.64	620.64
1	POLYETHYLENE	Small	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	93.77	37.74	37.74	37.74	93.77	93.77	93.77
1	POLYETHYLENE	Medium	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	384.10	85.22	85.22	85.22	384.10	384.10	384.10
1	POLYETHYLENE	Large	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	509.16	193.26	193.26	193.26	509.16	509.16	509.16
1	PVC	Small	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	119.69	45.97	45.97	45.97	119.69	119.69	119.69
1	PVC	Medium	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	338.53	59.55	59.55	59.55	338.53	338.53	338.53
1	PVC	Large	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	693.29	395.40	395.40	395.40	693.29	693.29	693.29
1	FIBRE CEMENT	Small	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	22.02	25.46	25.46	25.46	22.02	22.02	22.02
1	FIBRE CEMENT	Medium	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	113.33	53.95	53.95	53.95	113.33	113.33	113.33
1	FIBRE CEMENT	Large	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	327.67	254.96	254.96	254.96	327.67	327.67	327.67
1	CONCRETE	Small	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	601.77	66.90	66.90	66.90	601.77	601.77	601.77
1	CONCRETE	Medium	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	2,180.79	108.43	108.43	108.43	2,180.79	2,180.79	2,180.79
1	CONCRETE	Large	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	6,107.61	355.29	355.29	355.29	6,107.61	6,107.61	6,107.61
1	OTHERS	Small	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	200.44	56.23	56.23	56.23	200.44	200.44	200.44
1	OTHERS	Medium	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	682.94	115.98	115.98	115.98	682.94	682.94	682.94
1	OTHERS	Large	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	1,651.67	484.13	484.13	484.13	1,651.67	1,651.67	1,651.67

APPENDIX E
SPECIAL INFRASTRUCTURE PROJECTS CONSULTED

ACUAES (2014). El Ministerio de Agricultura, Alimentación y Medio Ambiente inicia las obras del Tanque de Tormentas de Estiviel (Toledo) *("The Ministry of Agriculture, Food and the Environment starts works in Estivial storm water tank (Toledo)")*. Press release, published on September 15, 2014 on www.acuaes.com

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The main goal of this study is to understand the renewal investment needs concerning the urban water cycle in Spain. To achieve it, an inventory of the assets (networks and special infrastructures) that make up the integrated urban water cycle, in its current actual configuration, was developed. Also, the as-new replacement value of the cost resulting from setting up all that capital was calculated and, then, the annual cost of renewal investment to sustainably maintain the capital was estimated, stemming from different scenarios based on their renewal period. Therefore, the results of this paper are intended to raise awareness on overall renewal investment needs of the urban water sector, in order to ensure the continuity and safety of present and future water services, as well as to promote and maintain those infrastructures that guarantee the provision of water supply and sanitation services.

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