

Graphic Engineering in the Sustainable Preservation of the Municipal Heritage of Montilla (Cordoba, Spain) from the 18th Century: Master Builder Vicente López Cardera in Montilla

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Abstract: The change of territorial organisation in the 18th century in Spain was strongly related to the preservation of the local heritage. Academic architects, military engineers, and master builders coexisted to carry out the design and management of municipal construction works. The evolution of the figure of the master builder and the confrontation with architects and the guilds since the creation of the Royal Academy of Fine Arts of San Fernando posed an inflection point in this aspect. The first aim of the present study was to highlight the figure of Vicente López Cardera, master builder in the Council and Diocese of Córdoba between the late 18th century and the early 19th century, through his work on the municipal interventions in the maintenance of the construction works and infrastructures in Montilla (Córdoba, Spain) around the year 1794. The second aim of the study was to emphasise the role of graphic engineering in the conservation of municipal heritage in the Modern Age through the study of drawings and plans provided by him in the analysed documentation. His thinking in the approach to these works fits with the ideas of social hygienic improvements that began with the Enlightenment as well as with the concept of sustainable development in culture; hence, his work is relevant in the sustainable development planning of cities in the present. With this study, missing heritage elements are also revealed, opening future lines of research that lead to their virtual reconstruction and the promotion of tourism in rural areas.

Keywords: architecture; graphic engineering; cultural heritage; drawing; civil works; sustainability; master builder; restoration; civil engineering

1. Introduction

1.1. The Evolution of Training in Graphic Representation in the Construction Guild

Architecture is considered one of the seven fine arts, along with sculpture, dancing, music, painting, literature, and cinema. According to Vitruvius, architecture was a science decorated with other sciences. Architects also had to be dominant in literature, arithmetic, geometry, optics, and drawing. Moreover, architects had to be trained in history, philosophy, music, astronomy, medicine, and even law [1]. These principles are still in force nowadays, although they have evolved, as was pointed out by professor Pozo [2]. It is worth highlighting that geometry, arithmetic, and graphic representation have provided an unmeasurable number of instruments throughout history and have developed along with these sciences. Thus, from the 18th century, in order to be admitted to the Academy of Fine Arts of San Fernando, it was a fundamental requirement for candidates to have enough training in geometry and drawing [3]. Currently, it is also necessary for the new architect to have an integral training that allows him/her to create by “playing wisely,

correctly and magnificently with the volumes gathered under the light” [4], highlighting the relationship of this skill with geometry and graphic representation.

Vitruvius, the first master builder of this art, also defined architecture as having six elements: order (fair proportion among the elements of a construction work); disposition (plan, elevation, and perspective); eurhythmy (elegant and beautiful appearance, which is achieved when the elements of a construction work are adequate and symmetric); symmetry (harmony of all and each of the parts that make up the construction work); decoration (the correct appearance of the construction work); and distribution (appropriate administration of the materials and terrains, along with the adjusted and reasonable costs) [5]. This sets the basis for the first roots of what we nowadays know as graphic engineering, that is, “a set of graphic communication techniques used by engineers, architects and designers to express ideas”, a universal language among professionals [6].

Construction is one of the oldest guilds in Spain. In fact, the oldest known is the Barcelona guild of stonemasons, which was founded in 1211 [7].

The figure of what is today known as the architect has received different names throughout the centuries: builder, master builder, geometrician..., etc. According to Ruiz de la Rosa, little is known about this figure in Islamic and Byzantine architecture; however, in the late Middle Ages, it was already a “guild, consolidated and organised activity”, with geometry playing an important role, through which different Romanesque and Gothic forms were produced, whose evolution intensified the relevance of drawing and plans in graphic representation [8].

Specifically, the present study is focused on the figure of the master builder. These were qualified professionals with the legally recognised capacity to design and manage construction works who, in the 18th and 19th centuries, got into conflict with architects. Authors such as Domínguez-Burrieza [9] have analysed the brief bibliographic notes from some master builders from the 19th century who graduated from the Free School of Master Builders of Valladolid. However, with few exceptions, the literature does not show any master builders from the 18th century in Spain [10]. The degree of Master Builder was abolished by the royal decree of September 18th, 1796, although it was reestablished in 1816 [11].

The mentioned conflict between master builders and architects is strongly linked to the creation of the Royal Academy of Fine Arts of San Fernando in Madrid in 1752 [12], which would be the promoter of a “new architecture”, competing with the guilds for the control of this old science. With the publication of their statutes in 1757, the competences of architects, master builders, and stonemasons were clearly defined, and it was determined that the Royal Academy had to recognise the capacity of these professionals to estimate, manage, and measure construction works [13]. In 1765, a royal resolution was published, which established that architect and master builder candidates had to pass an exam and be evaluated by architects approved by the Royal Academy. In this context, confrontations emerged between the guilds and the Royal academy for the control of the competences of the mentioned figures. Similarly, on 23 November 1777, the Count of Floridablanca signed a royal decree, which established that when the structure of public construction works was projected or modified, the Royal Academy had to be consulted. This centralisation in the Royal Academy caused numerous delays in the execution of the construction works, in addition to conflicts with the guilds. In 1786, the Architecture Commission was created in Andalusia, which assumed the previously mentioned competence of the Royal Academy [14]. This event did not pose a definitive solution, and these kinds of conflicts continued through the years.

In this sense, the administrative organisation evolved considerably in the 18th century. At this stage, the municipal regime was in crisis, although we should start in the period between 1707 and 1716, with the *Nueva Planta Decrees*. These were the foundation of the reform of the state and its organisation [15]. The Council of Castile, as a higher organisation at the central level, controlled territorial institutions and other immediate institutions with functions delegated from the central power, such as superintendents,

governors, mayors, and aldermen, among others [16]. The functions of the latter included the administration of privately owned property and the creation of the ordinances and regulations of the municipality. The expenditures that the council had to assume included the repair of bridges, roads, fountains, and municipal buildings. These expenditures were defrayed through the City and Proprietor Council, with private funds. Thus, the regulation of expenditures and income was established with regard to investments in public construction works and the maintenance of council real estate [17,18]. The sources of income that composed the private funds were varied. The most important of these funds were the income from the rustic properties of the municipality and urban real estate properties, the rents obtained from the collection of rights, the contributions for the use of the municipal facilities, the imposition of charges on economic activities, the income from municipal property rights and census, etc. [17]. It is important to take into account the serious fiscal problems of the analysed period; the municipalities were greatly indebted due to the investments in public construction works. To solve this problem, the state decided to create, at the local level, the so-called City and Proprietor Councils, which were controlled by the Council of Castile, as was established by the royal instruction of July 30th 1760 [19]. This organisation was managed by the governor, whose function was to monitor the local estates. The interventions of master builders, such as López Cardera, in the municipal public construction works were substantially important.

1.2. Master Builder Vicente López Cardera

He was a master builder of the Council of Córdoba and of the Diocese of Córdoba in the second half of the 18th century and in the early 19th century.

No studies have been exclusively focused on the figure of Vicente López Cardera, who graduated as a master builder from the Royal Academy in 1787. The aim of the present study was to compile and highlight the contribution of the municipal works, from both the documentary and graphic perspectives, carried out by this Cordovan master builder in Montilla, where he conducted few, but important, interventions, which made him famous in this region. We analysed the procedures and actions taken in the study period for the preservation of the heritage and civil engineering works, which are highly present in this municipality from the Roman Age and key to the quality of life of the citizens. Among his works, it is worth highlighting the construction of roads, bridges, sewers, drinking water channeling, dams, harbours, dikes, etc. Thanks to this research, it was discovered how relevant some buildings (no longer existing) were for the city of Montilla, such as the city hall and the slaughterhouse; this can set down future lines of research. In the 18th century, this science underwent a special booming following the ideas of the Enlightenment; the appearance of the towns and their roads changed substantially as a consequence of all these public construction works [20].

The relationship between the conservation of local heritage in the Modern Age with graphic engineering and the sustainable development planning of cities is highlighted thanks to the analysis of the plans and drawings of the contribution of López Cardera.

1.3. Literature Review

The preservation of the architectural and cultural heritage of cities is a matter of great importance, particularly the preservation of those elements that are under some type of historical–artistic protection [21–23]. As Go-Eum [21] says, heritage assets are not only part of the culture and history of the people, they also provide historical spaces for future generations, contributing to their sustainable availability through the application of photogrammetric techniques or 3D scanning, among others [24–26]. Within this process, an archival study and analysis of the documentation related to the heritage must be the starting point, valuing not only the buildings or infrastructures themselves, but also the history and the most relevant characters related to them, which in turn are part of such heritage. In the world, there are numerous studies about water collection and channeling in cities. For instance, the improvement of urban planning in the Hellenic period led to the pursuit

of an efficient management of rainwater [27]. With the Roman Empire, the first water channeling systems were created, using complex engineering systems for the design of sewage and cesspools. Similarly, in the Byzantine period, and in Al-Andalus, the rivers were used as sewers and outlets to manage the hygiene of cities. In the Modern Age, a known example is the engineering work for the water channeling in Venice (Italy) [28].

In Montilla, the study conducted by Carranza-Cañadas et al. [29] was fundamental to knowledge about the first water channeling system, which was completed in the 19th century; it has served as the basis of future archaeological studies.

This methodology is being applied at an increasing frequency in the processes of cultural heritage conservation; these processes are also contributing to the enhancement of certain environments, in order to improve the economic development of cities. Andalusia is a Spanish region with a wide cultural heritage, which is being additionally valued through its analysis, using a combination of history, architecture, and the application of new technologies. In this context, important works should be highlighted, such as the Mosque-Cathedral of Córdoba [30,31], the Alhambra palace of Granada [32,33], and other monuments that are part of an environment of great wealth. Their enhancement through these research works is an incentive for their conservation for tourism as one of the current important sources of economic development [23,34–40].

In addition, within the framework of the 2030 Agenda, there is the undertaking of the rehabilitation of heritage from an eco-sustainable point of view, which seeks the efficiency of the materials and resources used [33,41–44]; these aspects are rooted in the techniques, procedures, and materials were used since Roman times and reappeared with the ideas of the Enlightenment, as can be seen in the work of López Cardera. In the study period, the current concept of sustainability and environmental care did not exist, and the rivers were often used as landfills; however, the emergence of the hygienist movement with the Enlightenment promoted awareness in this respect and a later regulatory development. Table 1 shows some of the most important regulations in connection with urban planning, architecture, and hygienism in Spain. Since the 20th century, and with the entry of Spain into the European Union, these regulations have become more strict and specific; thus, priority topics are established in the so-called urban agenda of cities, as defined in the 2016 Pact of Amsterdam, pursuing the care of the environment and the sustainability of cities.

Table 1. Milestones regarding hygienist movements and urban planning in Spain.

Year	Milestone
1681	India laws
1719	Treatise of Teodoro de Ardemans about municipal ordinances
1784	Royal instructions on what governors and mayors of the Kingdom of Córdoba must observe
1812	Constitution (first Spanish constitution)
1846	Royal order of Pidal about city mapping
1849	Regulations of July 14th about aligning town roads
1856	Dr. Montau's regulatory proposition about public safety and hygiene
1864	Town widening law
1866	Water law
1879	Water law
1895	Law of March 18th on sanitation
1901	Decree of April 12th that establishes the general management of public construction
1910	General basis of the hygiene regulations
1913	Hause survey (about city sewers and other sanitation issues)
1919	Membrillera report about water supply

1985	Water law
1986	General sanitation law
1999	Construction ordination law
2013	Environmental evaluation law
	Coast law
2022	Law 7/2022 of April 8th on wastes and contaminated soils

At the regional and local level, further regulations have also been developed in this respect. In Montilla, it is worth highlighting the municipal ordinances of 1764 and 1889, and the water service regulation of 1872, which show that the population was becoming aware of the precepts of hygienism through legislative specification.

Nowadays, in the framework of sustainable development, a new concept has emerged, i.e., smart cities, whose main aim is to improve the performance of the three pillars of sustainability (environmental, economic, and social), using smart technologies to attain this goal [45,46]. However, as is shown in Figure 1, this is the result of the influence of the history and architecture of the different civilizations throughout the centuries. The approach of these smart cities is based on four pillars, i.e., institutional, physical, social, and economic infrastructure; thus, it implies a set of challenges [47–50].

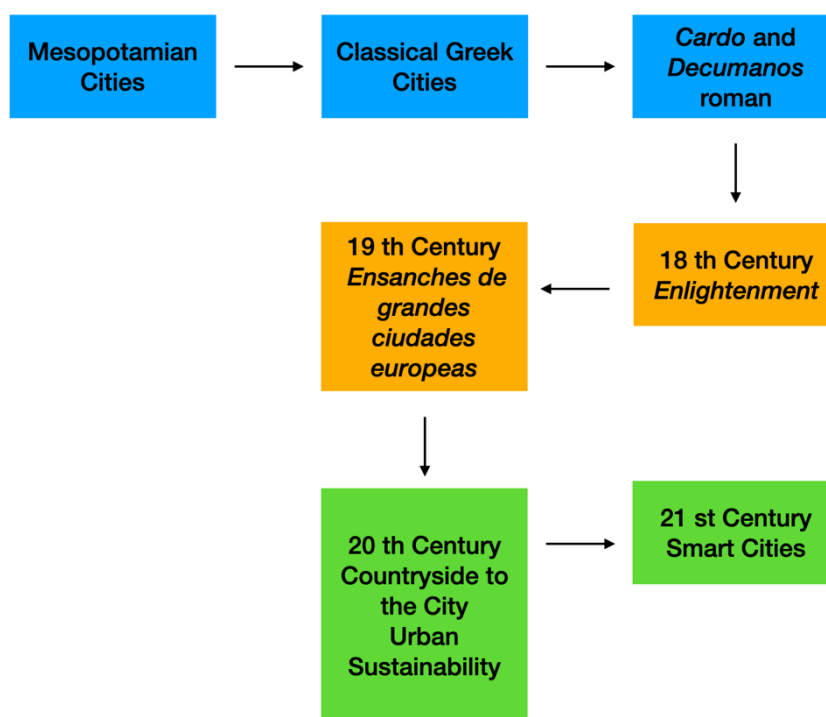


Figure 1. History line of the evolution of cities from Mesopotamia to current smart cities.

2. Materials and Methods

Vicente López Cardera was practically unknown in Andalusian architecture despite having intervened in very relevant pieces of its cultural heritage. Due to the lack of scientific studies exclusively focused on his work, the present investigation was based on a documentary analysis of the archives and libraries, such as the municipal archives of Montilla and Córdoba, the Manuel Ruiz Luque de Montilla Library Foundation, the Historical-Provincial Archive of Córdoba, and the Virtual Library of the Academy of Fine Arts of San Fernando, where an exhaustive research work was conducted from May 2021 to April 2022.

The starting point is an interesting unpublished manuscript guarded by the Manuel Ruiz Luque Library Foundation of Montilla (Córdoba). During the documentation work

in the mentioned archives, we found that the documentation was scattered, unorganised, and unclassified. To avoid the dispersion of the researchers during this process, we started by clearly establishing the goals and research criteria, in order to properly analyse and organise the information found. These research criteria were to search for the relevant documents related to the aim of the study and assess the state of the sources for the analysis and treatment of the information contained in them. Then, the collected information was synthesised, which allowed establishing some final conclusions, as well as future research lines.

To date, the figure of López Cardera has been addressed indirectly through studying his collaborations with other architects, analysing the evolution of the figure of the master builder and architect, delving into the origin of the Academy of Fine Arts and the architectural styles, and exploring the introduction of Neoclassicism in Spain. A bibliographic sketch of Vicente López Cardera was conducted by delving into the training of this professional and how it changed in the mid-18th century. For this, the search performed in the Municipal Archive of Cordoba was crucial, as it enabled the establishing of his filiation. Similarly, we analysed the document itself and the graphic engineering reflected in it, contextualizing the reasons that led to its realisation, based on the municipal organisation of that time. Lastly, we also explored the final execution of his construction works.

3. Results

3.1. Biography of Master Builder Vicente López Cardera

The personal life of Vicente López Cardera is practically unknown. The present investigation revealed unpublished data about the ancestry of this renowned Cordoban master builder.

He came from a family line of master builders (great-grandson, grandson, son, and brother of renowned master builders). His father was the Cordoban Fernando López Chozero, born in Córdoba in 1706; he married Rosalía Cardera Galbez in the parish of San Andrés of Córdoba (Palma del Río, 4 September 1720) [51]. He was also the brother of master builders, Juan, Rafael, and José López Cardera. His three brothers intervened in the reformation of the granary of Iznájar [52]. Juan built the tower of the church of Santa María de la Flores in Hornachuelos [53] and worked on different construction works of the diocese, such as the church of Santa María of Baena. A fifth brother, Roque, was a silversmith [51].

His exact birth date is unknown, although a document from 3 October 1777 provides a list of numerary architects of the Academy of Architecture of San Fernando, where Vicente López Cardera appears as a native of Córdoba, aged 32 years. Thus, this review allows the dating of his birth as 1745. His date of death is also unknown, as is whether he married or had any children.

On 2 June 1787, Vicente López Cardera passed the “coursework” exam, in which he performed the design of a house for a landowner, with labour offices. To this end, he used light yellowish laid paper, with gray ink and glaze, probably employing a drawing pen, protractors, and different rulers, among other materials. He designed the ground and main floors, the walls of the main facade, the plan of the staircase, and a sectional wall of the latter [54].

After passing the exam, he applied for the title of Master Builder to the Council of Córdoba. This was denied by the Royal Academy, which, since 1757, began to teach the studies of the architecture degree and urged the town halls to hire qualified architects instead of master builders [13]. Thus, a litigation began between both institutions, and in 1787, Vicente López Cardera was given the title of Master Builder of the Council of Córdoba. However, the tension between both professions was continuous and caused irreparable damage to the image of master builders [9]. As an anecdote, it is worth highlighting the initial arguments between López Cardera and the academic architect Ignacio Tomás y Fabregat, who, in 1790, arrived in Córdoba to manage the municipal and diocesan

construction works [14]. Then, these arguments between them were resolved, and they collaborated in the following years.

The professional activity of López Cardera was very wide, both as a master builder of the Diocese of Córdoba and as a master builder of the Council of Córdoba. Among all his works, worth highlighting are the Pozoblanco town hall project (1787); the reconstruction of the tower of the church of Magdalena de Córdoba with his brother Juan (1790), with whom he also participated in the restoration of the Martos mill that very year; the restoration of the jail (1791); a report on the wall of the Guadalquivir riverbank in its course through the city [55]; the gate of the shrine of La Salud; the sanctuary of Nuestra Señora de la Fuensanta; and the construction of the church of Juramento de San Rafael [56], among others.

3.2. Analysis of the Intervention Project of López Cardera in Montilla

3.2.1. Historical Background in Architecture and Urban Planning in Montilla

The architecture and the urban planning of a city are the foundation of the daily life of its citizens. It is necessary to maintain the urban space under basic conditions of safety and hygiene [57], which is why Vicente López Cardera arrived in Montilla in 1794.

In the 18th century, Montilla was one of the largest towns of Córdoba, which is settled on a hill crowned by the ruins of the old castle of the Marquesses of Priego and surrounded by fertile lands; thus, agriculture was its main source of wealth; most of these agricultural lands belonged to the House Medinaceli [58]. In 1752, Montilla had a total area of 16,784 hectares and an approximate population of 3000 inhabitants [59]. The city had numerous properties, including 3533 bushels (agricultural area that varied among territories; in Andalusia, one bushel was about 6440 m²) and different assets, such as chapter houses, the jail, the slaughterhouse, butcher's shops, tobacco stores..., etc., which produced a great income for the city. Buguella quantified it as 43,431 *reales de vellón* (legal currency in Spain in the 18th century, created in the 17th century), although the city also had to assume expenditures and different debts. In the Montilla of the late 18th century, the municipal organisation consisted of a series of public positions, assigned by the crown in favour of the Marquis of Priego, who selected the mayor and the twelve governors of the municipal government [59].

The chapter minutes of 1792 show the need to carry out important restoration works in the jail and other public offices. In view of the bad situation of the private funds to conduct these works, on 26 November it was decided to ask the Supreme Council for permission to organise bull fights for six days, with the aim of raising the necessary funds [60]. On 2 October 1793, the council requested a report on the construction works in the public buildings, putting Vicente López Cardera in charge of these works in exchange for forty *reales* per day [61] (Legajo 270 A, Expediente 4).

In 1794, the intendent of the city of Córdoba, D. Juan de Torres, ordered López Cardera, as head master builder, to write a report on the state of preservation of a series of buildings, fountains, and bridges in Montilla, some of which have already disappeared, such as the town hall, the slaughterhouse, and the jail. With respect to this visit, Vicente López Cardera wrote a report of great relevance, which is the main basis of the present study [62]. Its importance lies in the fact that it provides information about buildings that do not exist today, as well as the description of their state of preservation, the interventions to carry out, the materials to use, the cost estimations..., etc. Thus, López Cardera focused his interventions on some of the main municipal buildings of the city and on the water supply pipes, as is observed in such a report from 6 March 1794.

Years earlier, in 1755, the Lisbon earthquake took place; it is identified as a "destructor earthquake", and it caused great damage in Montilla [23]. The mentioned earthquake affected all the buildings of the city, according to the records of the time [63]. Among the consequences of the damages recorded, 52 houses were declared unfit, the tower of the parish of Santiago Apóstol was cracked, and some of the chapels and pillars of the latter

were destroyed. The reconstruction works of these buildings were prolonged for a time; for instance, in 1804, the town hall of Montilla declared the ruin damage of the church of Santiago, and, two years later, the tower of the church of La Rosa, located next to the town hall, was demolished [35]. The work entrusted to López Cardera may have been related, among other matters, to the consequences of such a devastating earthquake for these buildings and the basic infrastructures of the city. Moreover, a letter from intendent Juan Torres, written on 17 July 1804 [64], shows that, although such interventions had been necessary for some time, they could not be started due to a lack of financial resources because the money had been used to expand the pastures for horse breeding. For the realisation of these works, Vicente López Cardera was accompanied by Montillian master builder Cristóbal Carbonero [61] (Legajo A, Expediente 4).

3.2.2. State of the Question: Report on the Preservation of Municipal Buildings of 1794

The document is structured in several parts and has a clear methodology. In it, López Cardera justifies his capacity to carry out the works. Over thirty constructive elements are examined and are grouped into four blocks: civil architecture buildings (town hall, jail, house of the mayor and guard, barracks, slaughterhouse, and several private houses); a building of religious architecture (school of Jesuits); eight bridges crossing streams around the town; and fountains.

Next, he detailed the interventions to be carried out. To this end, he followed the same methodology: he described the building or element in question, indicating its dimensions, the actions to be conducted, the materials to be used, and the required budget. In some of them, due to their nature, we found some additional contributions that are described below.

The report also established the total cost of the interventions (125,434 *reales de vellón*), proposing to the intendent the acquisition of the described materials and identifying the origin of some of such materials. At the same time, he also proposed that the construction works should be conducted in the summer, from six o'clock in the morning to twelve o'clock in the afternoon and from two o'clock in the afternoon.

The last part of the report is dedicated to the graphic documentation. It includes the plans of some of the buildings as appendices; some examples of these are the plans of the School of La Encarnación (Figure 2), the house of the guards of El Carrascal (Figure 3), the sewers of the La Guta stream (Figure 4), and the fountains of Los Álamos (Figure 5) and El Caño (Figure 6). A later document complements this report, and it includes the plan of the slaughterhouse (Figure 7).

Table 2 shows the classification performed, as well as the cost estimated by López Cardera to carry out the interventions. As can be observed, the most important lot was allocated to the municipal buildings, followed by the lot assigned to the elements of the water supply and sewage network, which were key to keeping the population safe from possible diseases and epidemics.

Table 2. Itemisation of the construction works ordered by López Cardera and the costs estimated by this master builder.

Municipal Buildings	rv *	Houses	rv	Bridges and Sewage	rv	Fountains	rv
Town Hall	997	House in Molinos Baxa St	2550	Bridge of Huelmor Stream	1110	María Fountain	9770
Royal Jail	12,215	Houses in D ^a María St	340	Bridge of Los Álamos Stream	0	El Álamo Fountain	106
Governor's House	5484	School of Expelled Jesuits	2595	Bridge of the Hill Road	0	El Fontanar Pillar	96

Barracks	7775	House of D. José Palomino	418	Sewage of Paso Vereda Realenga	0	El Pachía Fountain	256
Old Barracks	27,750	House of D. Francisco Bastia	320	Bridge of Las Monedas Stream	0	El Caño Fountain	3400
Cow Slaughterhouse	11,254	House of D. Antonio de Frías	442	Benabente Bridge	810	El Cuadrado Fountain	9400
		House of D. Antonio Ximenez	360	Sewage of the Guta Stream	3585	La Higuera Fountain	1300
		House of D. Josef Garcia Valenzuela	687	Sewage of the Benabente Stream	4500	El Pachía Fountain	220
		House of D. Francisco Infante	743	Bridge of the Huelma Stream	3257		
		Houses of the Guards of El Carrascal	5210	Sewage of the Huelma Stream	1500		
				Bridge of the El Caño Fountain	0		

* Reales de vellón.

In this interesting work of López Cardera, the concern of the master builder and the civil authorities of the time for the conservation and improvement of the heritage is clearly observed. The powers of the governors and mayors in late-18th-century Spain included those for clear urban planning and of hygienist significance, such as the reconstruction of ruined buildings, attending to the water supply, the creation and maintenance of sewage systems, and the promotion of hygiene in the population through regulations that guaranteed healthiness [65]. An important figure for attaining this was represented by the master builder, such as López Cardera. Through works such as the one analysed in Montilla, these professionals contributed to the conservation of the town's history by protecting and preserving its buildings and infrastructures, some of which are studied in this article. Moreover, in the city and province of Cordoba, their role was obvious, and they had remarkable importance in the conservation of the Martos mill, a Roman water mill located next to the Roman bridge. It is an architectural and civil engineering work that was used in that time for the extraction of water from the Guadalquivir River in its course through Cordoba. These aspects are very current today in relation to Goal 11 of the 2030 Agenda [66], which focuses its attention on the protection and safeguarding of the world's cultural and natural heritage; on improving planning in urban, peri-urban areas, and rural areas; and on the need to manage water supplies and pipelines for the proper management of natural resources and the safeguarding of public health. It is a clear example of the benefits for urban development of the sustainable conservation of cultural heritage [67–69].

Civil Architecture of López Cardera

Vicente López Cardera started with the most important civil architecture building of the city, i.e., the town hall, which was then located in La Rosa Square and was later moved to the old cloister-hospital of San Juan de Dios in 1893 [70] (p. 71), where it is nowadays.

After that, he worked on the royal jail, indicating possible points from which the prisoners could escape, as well as other measures and advice to prevent jailbreaks. Along with the barracks, it was the largest economic lot, due to the numerous works to be conducted, which ranged from roofs, floors, yards, doors, windows, bars, prison cells..., etc. The estimation for the roofs alone amounted to 1993 *reales de vellón*. He proposed the construction of a service for the building, which he called “secret”. Thus, to carry out all these works, he estimated a total of 12,215 *reales de vellón*. In the governor’s house, he focused particularly on repairing the roof and replacing the floors, for a total of 5484 *reales de vellón*. Then, he addressed the intervention in the barracks and the house next to it to perform repair works on the yards and habitable stables. He estimated a budget of 7775 *reales de vellón* for the barracks and 27,750 for the house next to it. This building was in a very poor state, with some of the roofs and rooms collapsed; thus, it was necessary to rebuild and conduct important repairs in the different rooms.

In 1791, the town hall of Montilla asked the City and Proprietor’s general accountant for permission to rebuild the slaughterhouse, located outside of the city walls, using the remaining private funds. It was approved with the decree of 28 June 1791 [62]. A budget of 10,494 *reales de vellón* was granted. The works were not immediately executed, and thus López Cardera said that the slaughterhouse was in such a poor state that he had to design a new one (Figure 6), for which he estimated a cost of 11,254 *reales de vellón*. The graphic document represents a large, uncovered yard for the reception of cows, which allowed the accessing of two covered rooms: a pen for the animals, and a passage to the slaughter room, which is not represented in the plan. It is worth highlighting that, for the Royal Academy of San Fernando, the projection of the consistories was extremely important for the process of the implementation of their precepts [71].

None of the civil architecture buildings included in the reports of López Cardera have survived to the present time; thus, the value of this study is even greater. These buildings are highlighted by the detail with which López Cardera described them and the accompanying graphic representations. Moreover, this will enable their 3D reconstruction in future research lines. The budget allocated to the repairs amounted to 65,745 *reales de vellón*; this was the largest budget item in the report of López Cardera, followed by the one dedicated to the fountains, which shows the importance of the maintenance of these buildings to the civil authorities of that time.

Interventions in Houses

The report is also focused on several municipal houses, including some houses for schoolteachers, in which the interventions were carried out mainly on the roofs and floors. Moreover, in some of these houses, the report indicates the necessary repair of doors, stretchers, and windows. López Cardera also inspected the old School of La Encarnación and the houses of the guard of El Carrascal.

The School of La Encarnación had belonged to the Company of Jesus. It was founded by the Jesuit priests in 1552, under the auspices of the 2nd Marchioness of Priego. This building was located where her father, the 1st Marquis, created Los Remedios Hospital for the Poor in Corredera St. [72]. It had classrooms and meeting rooms for the students, as well as rooms for the Jesuit priests, a yard with cloisters, and a church [73] (pp. 93–96). In the mid-17th century, the construction of a larger church was started, although it was completed three centuries later, in 1944. This new church is the current Basilica of San Juan de Ávila, and it holds the remains of this Father of the Church. In 1767, the Company of Jesus, by virtue of the Pragmatic Sanction, enacted by Carlos III, was expelled from Spain, and its assets were seized by the state. Two years later, the community of the Franciscans of Montilla asked for permission to move from the cloister outside the walls of San Lorenzo to the School of La Encarnación [74–77]. They took possession of it in 1792, changing its name to San Francisco Cloister, although it was not until 1794, after the interventions carried out in the building as a result of the report of López Cardera, when they

occupied most of the rooms of the school, except for the schools and houses of the teachers. They remained there until the ecclesiastical confiscations of Mendizábal in 1835 [78].

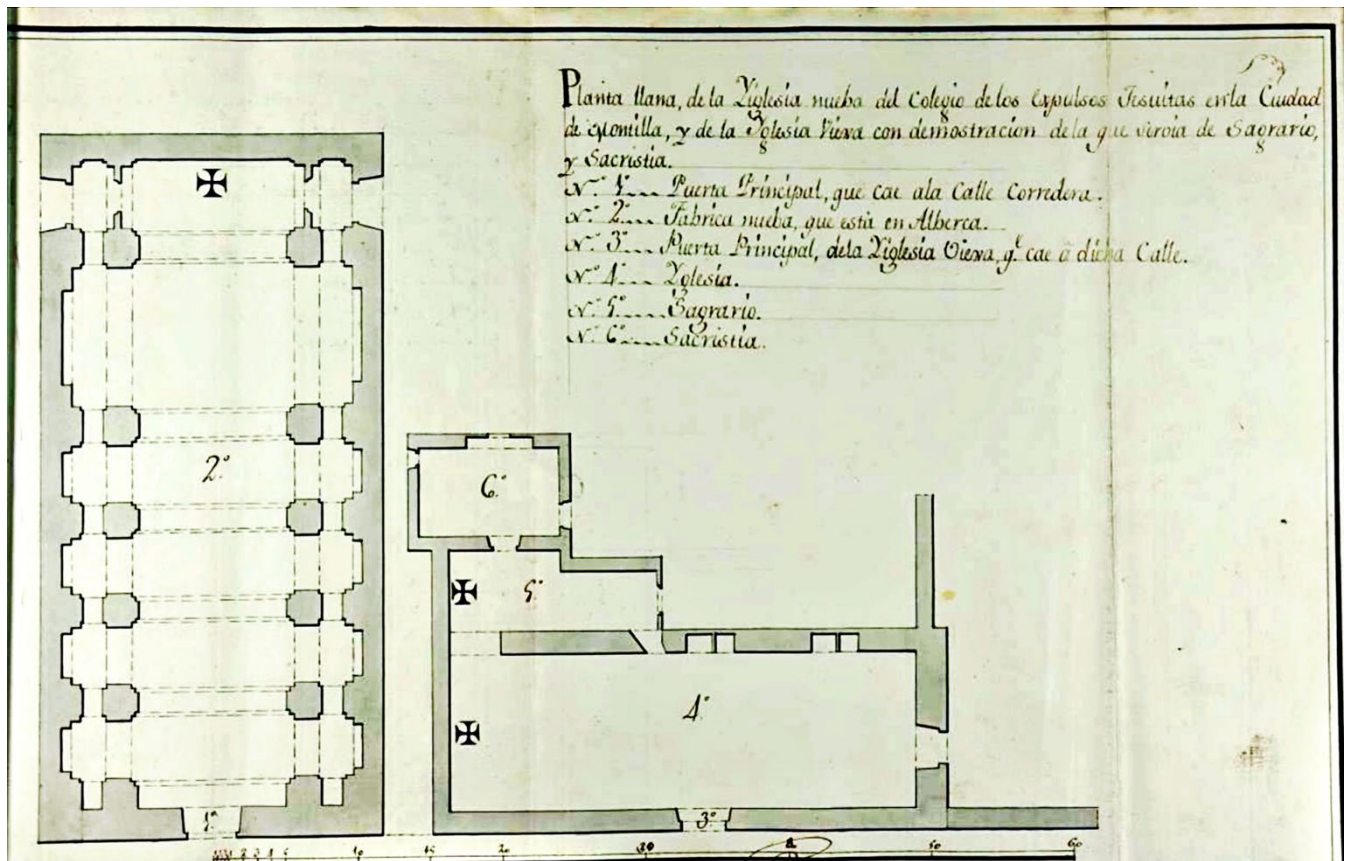


Figure 2. Plan of the churches of the School of La Encarnación [62].

In Figure 2, drawn by López Cardera, there is the plan of the original church on the right, and on the left, there is the church under construction. According to the report, he drew these so that the intendent could clearly see the space that was not being used at the time, as the old church (on the right) had been stripped of its characteristic assets to celebrate mass, and the new church (on the left) was unfinished, or “in ruins”.

The last building, within the block of “houses”, is the house of the guard of El Carascal estate. Its state was so poor that it was necessary to rebuild the house. To this end, López Cardera performed a new design (Figure 3) for its construction, and without any description, he only indicated the estimated budget for its execution (Table 2). From the careful analysis of this drawing, we observed that it provided us with important information about the customs for the ranches of the peasants in Andalusia at the time. It was a construction divided into two floors, with a part dedicated to the storage of the harvest (n.12) and another part for housing the estate guard (n.3) and the workers.

As can be observed, they made use of the arches, which are indicated in the drawing with the number 8, to fit the beds under them (No. 9), near the fireplace that provided them with heat and in which they could cook their food (No. 5).

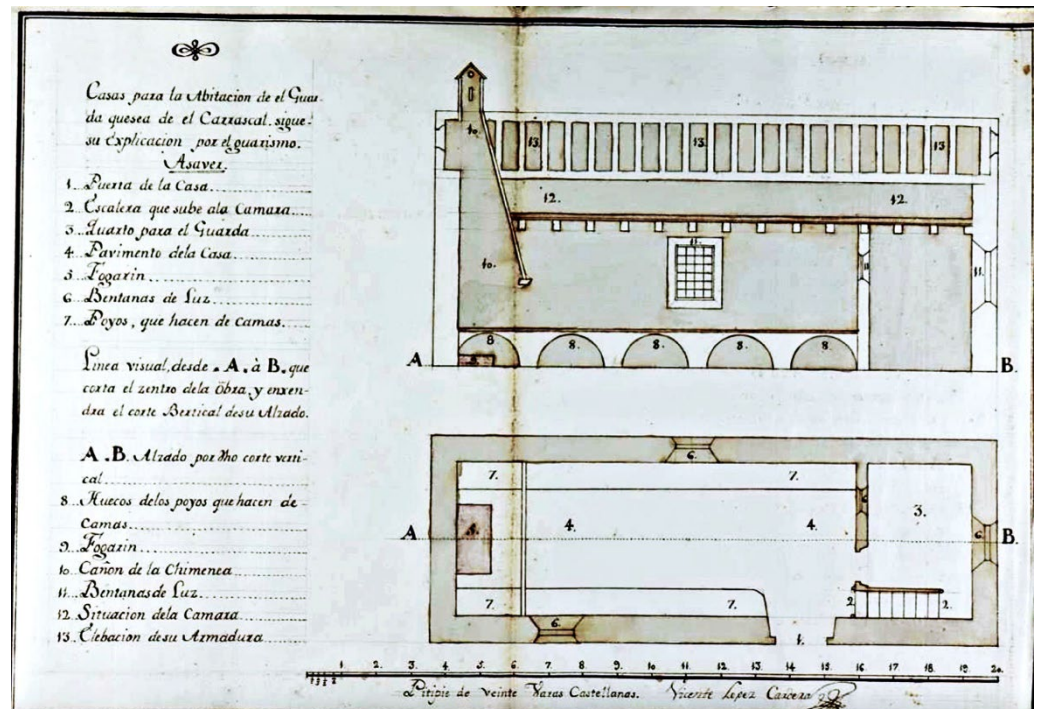


Figure 3. Design of the new house of the guard of El Carrascal [62].

Bridges, Stream Channeling, and Fountains

Bridges, fountains, and sewage networks were elemental infrastructures for life in the cities. Their care and maintenance were the responsibility of the town hall. All these works posed serious problems, such as the construction, repair, and maintenance of the water level and the hygienic measures for their cleaning [79]. Bridges were a key element for communication between towns, to the extent that the Academy of Mathematics of Barcelona promoted the writing of a treatise about the construction and maintenance of bridges in the 18th century. It is worth highlighting the works of Miguel Sánchez Taramas, professor of the mentioned institution, who translated a treatise of John Muller about this topic, expanding it with his contributions. The treatise, entitled “The twenty-one books of inventiveness and machines”, addresses this topic meticulously; it pays special attention to the idea that establishing a correct placing of the bridge, close to the roads, would help the construction economy and its later preservation, as was also stated by Brother Francisco de San Nicolás, who pointed out the need to preserve the bridges, and that such a need would be lower if the materials and the technique used in its construction were better [20].

The area of Montilla was very rich in water, and thus it had a large number of fountains and wells that supplied the city. In 1872, a water channeling system was created from the El Cuadrado spring, thanks to engineer José M^a Sánchez Molero [29,79]. The supply of water, so necessary for hygiene and health in the cities, was achieved through a series of fountains, in addition to the wells, which were located in some of the private houses. The sanitation of the water entry points into the houses and fountains that supplied the cities was very important to counteract the high rate of mortality derived from the poor hygiene conditions [80,81]. The owners of the lands where the water flowed, supplying the public fountains, sold, rented, or gave their exploitation to the town hall, other institutions, or private clients [82]. It is known that in 1777 there were no public fountains in the centre of the city, and that the deepest wells were forty yards deep [83] (ff. 193–194). Therefore, in his work, López Cardera paid special attention to their inspection and intervention propositions. His knowledge of hydraulic engineering would probably have come from the treatise of Teodoro Ardemans, an architect, writer, and higher plumber of Madrid who, among other works, elaborated the 1720 Madrid Ordinances [82], which was a key piece

for architects and master builders of the 18th and 19th centuries, as well as a treatise exclusively dedicated to the topic of water [84]. These works were, in turn, fundamental for the Marquis of Ensenada in the construction of his famous Catastro around 1749.

Most of the stream bridges (Los Álamos, Morente Road, Las Monedas, and La Salud Fountain) were in good condition. Of the seven bridges enumerated, only three required some intervention: (1) the Benavente bridge, which communicates with Cabra and Granada, (2) the Huelmor bridge, and (3) the Huelma bridge, on Córdoba Road. The interventions in the bridges were mainly focused on reinforcing the man guards or walls and cleaning their holes.

Regarding the sewers, López Cardera proposed intervening in those of the three streams: Guta, Benavente, and Huelma. The sewer of La Guta was in such poor condition that it had to be built again, and the report specifies the work that had to be conducted (Figure 4).

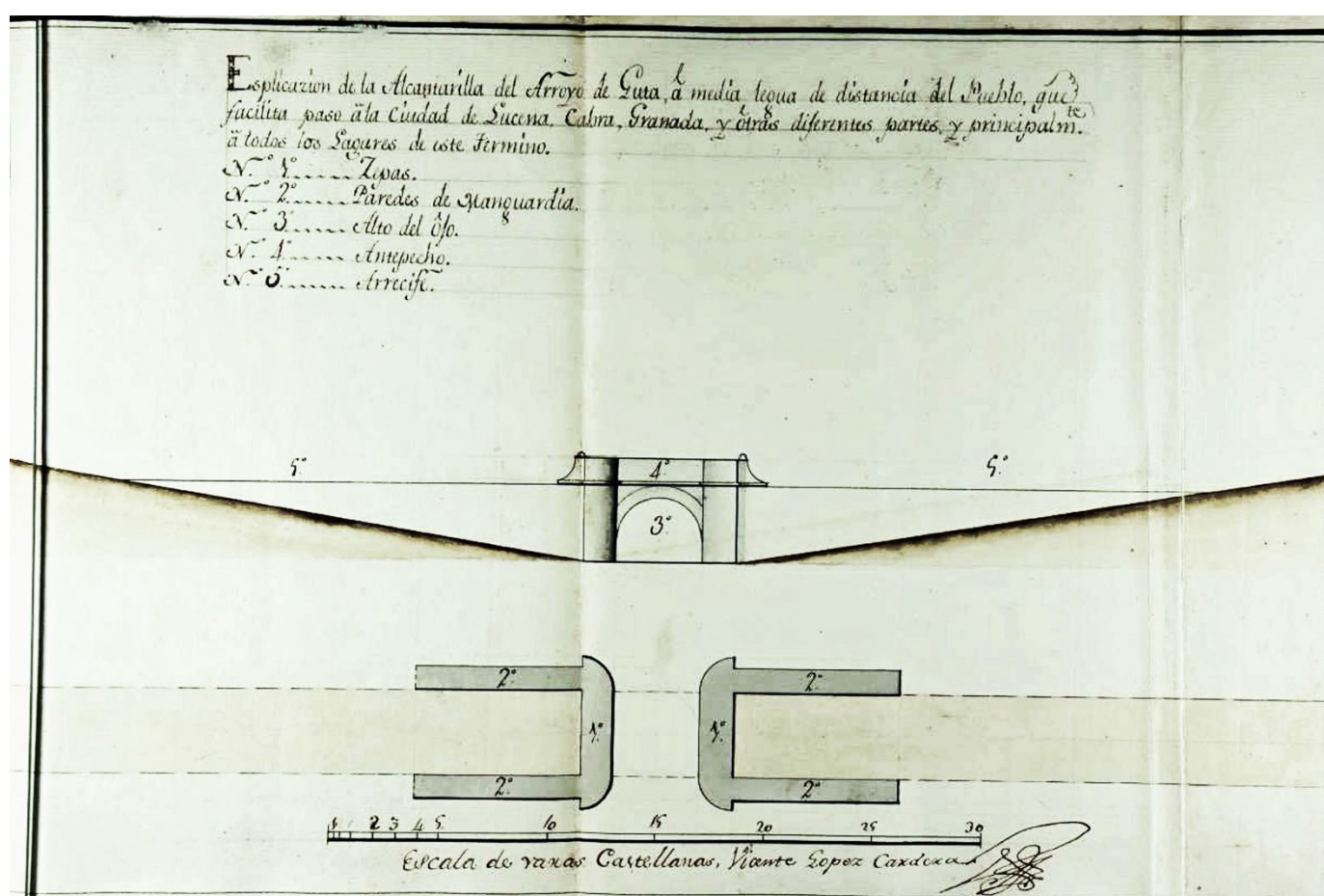


Figure 4. Plan for the construction of the sewer of La Guta stream [62].

Regarding the fountains, López Cardera first addressed that of Santa María, which was the main fountain of the municipality at that time and required the repair of the stone pavement to make it passable. This fountain, currently nonexistent, was one of the oldest, with its first construction dating from 1512 [85]. For El Alamo fountain, López Cardera considered it necessary to rechannel the water and build a new pillar and pavement, as is shown in the drawing of Figure 5, representing the plan and walls of the water tank (A,E), the channeling (B,F), and the pillar (G), which would be connected with the rubbery (C) and the fountain itself (D,H).

These works were executed by master builder Cristóbal Carbonero, who accompanied López Cardera in the inspections to these places. The documents of the Municipal Archive of Montilla contain a testimony of Carbonero's, which states that, in addition to

the works ordered by López Cardera, a new network of channels was created from the fountain to the water springs [85].

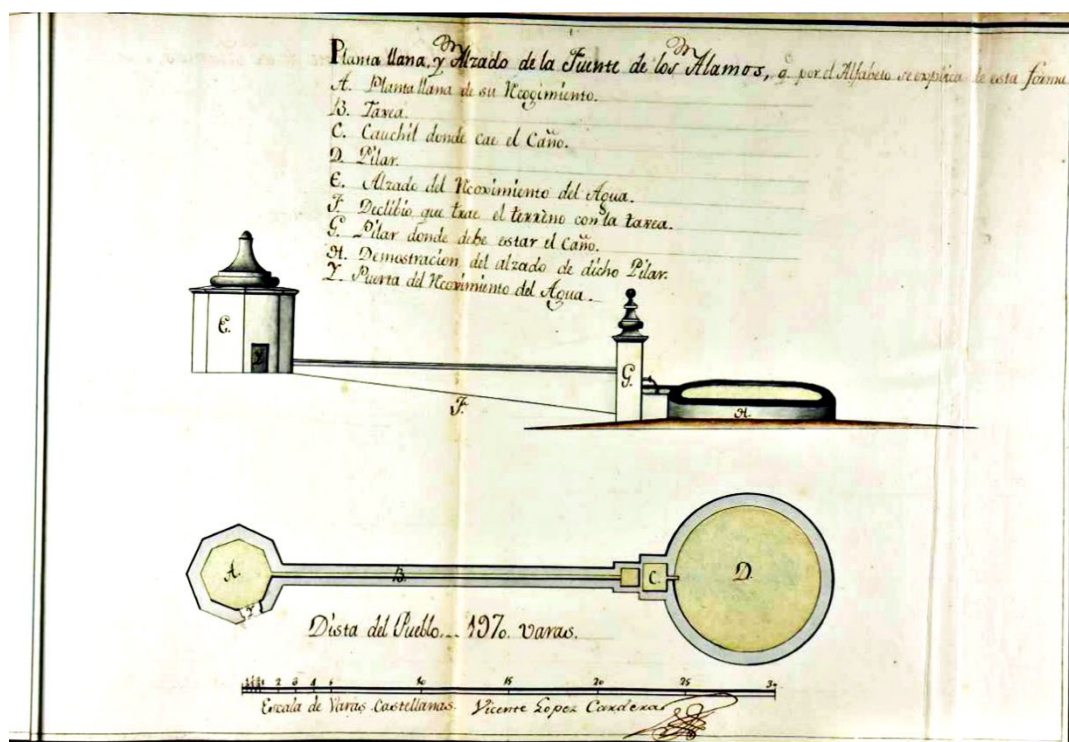


Figure 5. Plan for the execution of the construction works of El Alamo fountain [62].

The fountains of Nueva, Pachía, La Higuera, and El Pilar del Fontanar did not require great interventions. At most, they mainly needed the repair or construction of a stone pavement to improve the access for the inhabitants, as well as the repair of some minor faults. The Pachía and La Higuera fountains were restored in August 1775 [82] (pp. 203–205).

In the El Pez and El Caño fountains, the construction of a pillar was also required. Figure 6 shows the design made by López Cardera for the latter. Therefore, this work is an important contribution to the preservation of the country's historical and cultural heritage.

Many of these fountains are still working today, being part of the tourism municipal water supply network, through the so-called "Montilla Fountains Route".

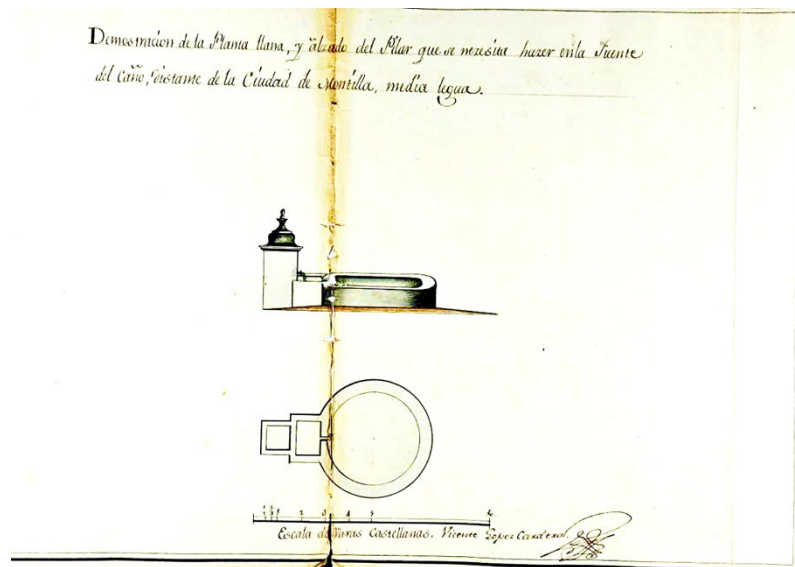


Figure 6. El Caño fountain: plan for the execution of the construction work on this fountain [62].



Figure 7. Plan of the slaughterhouse with the patio (B), animal pen (F), room (L), and building access [62].

3.2.3. Execution of the Construction Works of Vicente López Cardera

In the minutes of the Board of Proprietors of 1794, there is a letter from the intendent, dated 7 July, which mentions that, ultimately, due to the decrease in private income from the pastures for horse breeding, those newly built constructions estimated by López

Cardera were suspended [36]. In the execution of these construction works, the drawings provided by López Cardera played a fundamental role. In the Modern Age, unlike nowadays, there were no legal regulations or calculations comparable to the current ones, but they used drawings and plans, such as the ones that accompany the analysed report, which, along with the corresponding texts, facilitated the understanding of the interventions to be conducted.

The relationship of Vicente López Cardera with Montilla did not end at that point. In 1798, he was called by Blas Ramírez, Intendent of the Board of Proprietors of the city. He was asked to check the cloister of Santa Clara, where the rainfall of previous years had caused the collapse of its roofs and damaged in its subterranean water channeling; for this work he was offered fifty *reales de vellón* per day, i.e., ten more than in the previous work [64].

Thus, we want to highlight the role of Vicente López Cardera, in particular, and that of the master builders, in general, in the preservation of the built heritage, as well as in the efficiency of the buildings and in urban development. This is a very important topic in modern architecture, with an emphasis on solving the dialectal conflict between the preservation and the modernisation of buildings [85].

4. Conclusions

The present study reveals Vicente López Cardera as an important but unknown master builder of 18th–19th-century Córdoba, with extensive academic training, who was very concerned about the efficiency of the buildings in which he intervened. Several examples corroborate this assertion, such as the jail of Montilla, where he was concerned about preventing possible jailbreaks and maintaining basic health standards inside this building. This Spanish region has important architects who have left their legacy in different constructions; some of them are well known, such as Hernán Ruiz, Vandelvira, and Juan Antonio Camacho, and many others are less known, as is the case with López Cardera.

Studies such as the present one are of great importance as they promote the enhancement of the cultural heritage of the regions, their constructions, and the professionals who carried them out, delving into their history, thought, construction techniques, etc. The case, for example, of Juan Antonio Camacho, has been highlighted through the recent studies carried out by Alicia Baena [34,35], where we found similarities with López Cardera: they were both important and unknown figures of Spanish architecture who deserve to be valued. The document is a historical discovery and deserves to be highlighted by modern science.

The report of López Cardera (the documentary basis of this research) was an important example of the concern of the town hall of Montilla about the preservation of basic municipal infrastructures. This memorial can be a reference of the state in which many of the buildings of the city remained after the Lisbon earthquake. Similarly, this report helps to know the administrative process involved in the realisation of the construction works that depended on the local government. The problems with economic solvency of the municipal organisms prevented some of the actions projected by López Cardera; similarly, just as different events that have occurred over the centuries have permitted the conservation of these construction elements, others have not.

The application of 3D representation techniques is key to this purpose, as they facilitate precise knowledge of the elements themselves, as well as the discovery and recovery of lost heritage. Photogrammetry also offers important information, highlighting the ability to discover details and the fact that it can be used in places that are difficult to access or even inaccessible, which is why it is highly applicable in these processes of the conservation and recovery of construction heritage. In this way, modern technology contributes to this effort to transmit information about culture, history, and architecture to future generations and favours the promotion of digital cultural tourism. For example, the study of Carranza-Cañadas [29] produced a 3D modeling of the water collection of the El

Cuadrado fountain, and the topography of the terrain was determined by attending to the plans of Sánchez Molero, which served as a basis for future archaeological studies on the determination of their exact outline.

The drawings and graphs made by López Cardera, together with the descriptions that he presented in the memorial, provide important information. We highlight here the plan and elevation of the El Carrascal guard house (Figure 2), which provides interesting information on this type of construction and the customs of the farmers of the time and those of the slaughterhouse.

This concern for the sanitation and maintenance of cities in the Enlightenment can be understood as one of the oldest emerging concepts of smart cities, which pursue the attainment of truly sustainable cities through the use of smart technology to fight the climate crisis and inequality, while also attempting to improve the quality of urban life.

Thanks to the work of this master builder and the use of new technologies, future lines of research are opened, in which, using 3D techniques, we can virtually and sustainably recover some of these lost municipal buildings, such as the town hall, the prison, and the slaughterhouse, and create rural touristic routes from the studies conducted.

This study shows that Enlightenment brought a change of mentality. The new ideas included the concepts of health and hygiene in the cities, which required the maintenance of a good water supply and sewage network that kept possible diseases and epidemics away from the population. In this sense, the construction works projected by López Cardera in the memorial presented to the town hall are a model of modernity.

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