BULLETIN OF INDUSTRIAL ARCHAEOLOGY AND SCIENCE AND TECHNOLOGY MUSEUMS

Water is a something vital and inseparable from the history of mankind, and has been used in three ways throughout history: in the domestic sphere, to water crops, and to generate electricity.
Water systems have contributed significantly to our industrial heritage. They were first introduced by the Romans, and in 107 AD, a network of sewerage and thermal baths were built in Barcino (modern Barcelona), by Luci Minici Natal.
Rec Comptal irrigation canal dates back to the 11th century. It originated in Montcada, crossed Sant Martí de Provençals, and took water from the river Besòs before emptying into the sea at the city's beaches.
The largest hydraulic civil engineering works in the whole country was bringing water to Barcelona from the river Ter, along with the system which drew water from the Llobregat river, which had treatment plants in Sant Joan Despí and Abrera.
In recent years, the construction of two seawater desalination plants in El Prat and Blanes, and more than 500 water treatment plants have provided Catalonia with an important hydraulic heritage.
From a historical point of view, the largest quantity of water was used for irrigation, and many small irrigation ditches built between the 14th and 18th centuries can be found in the Empordà. The Pinyana Canal is the oldest community irrigation system in Catalonia. It was first documented in 1147 when Ramon Berenguer IV granted the Lleida farmers a water concession from the river Noguera Ribagorçana.
Canals d'Urgell originated in the 16th century, and the first section (the Montclar tunnel) was inaugurated on September 29th , 1861. Today it is the most important irrigation network in Catalonia, together with Canal de la Dreta and Canal de l'Esquerra of the river Ebro. The exceptional Sèquia de Manresa, from the 14th century, is also worth mentioning.
The economic development of a country is closely linked to its supply, consumption and the cost of its power. Water was used to generate electricity in two ways: on one hand, the so-called mini-hydroelectric plants associated with the textile colonies; and on the other hand, the large power stations, notably FECSA, Hidroelèctrica de Catalunya and ENHER.

THE INTERNATIONAL HERITAGE OF THE WATER INDUSTRY. HISTORIC VALUES OF WATER SUPPLIES AND TREATMENT NETWORKS

Last April, the Agbar de les Aigües Museum (located at the Cornellà d'Aigües de Barcelona power station), together with the TICCIH (The International Committee for the Conservation of Industrial Heritage), organised an international conference entitled "The international heritage of the water industry. Historic values of water supplies and treatment networks".
The museum is located in the historic Aigües de Barcelona pumping station, and the director Sònia Hernández welcomed more than a hundred people to a series of presentations on sites, buildings and landscapes created by the water industry. For the first time the speakers also discussed the relative importance of various historical sites from a global perspective.
The conference concluded a year-long study carried out for TICCIH by the author of this article. The research was aimed at proposing guidelines for identifying the most exceptional water heritage sites around the world.
The conference centred around the paramount importance of the water industry's heritage, and its role in overcoming the "health crisis" of the nineteenth century, when industrialization drew a vast number of people to live close to the new factories, and the traditional methods of water supply and sanitation, such as wells, urban sources and septic tanks were soon overwhelmed. This resulted in repeated outbreaks of cholera, typhoid and yellow fever that terrorized the citizens and threatened to make living in cities impossible. Urban mortality grew alarmingly, not only among the poor, but also the wealthier citizens, who were equally vulnerable to infection.
The central idea that all cities undergoing industrialization had to face this sanitation challenge was raised by the key speaker, Professor Martin V. Melosi of the University of Houston, Texas, at the beginning of the conference.
Industrialization gave rise to the belief that diseases were caused by "miasmes" (foul odours and toxic air), and little by little, the water supply gradually acquired a scientific basis, especially when bacteria was discovered in the1880s. The way in which the city's water industry managed to overcome the health crisis bestowed its heritage with "exceptional universal value": it shows an extraordinary, collective response to a serious threat to the development of humanity.
The hydroelectric heritage in Augsburg, Germany, is a candidate for the Unesco World Heritage List. The legacy, stretching from 1400 to the last century, includes items from the beginnings of the hydroelectric power industry, such as pumps used in metal mine water treatment. The presentation was given by the project coordinator, Rolf Höhmann.
Dr. Manel Martín spoke about the way industrial cities such as Barcelona reacted to the health crisis. For example, the design and execution of the Eixample district, the city's famous extension, illustrates the influence of the theory of "miasmes", and a solution to the health crisis.
In Argentina, the water infrastructure was so important that the government insisted that the new water pumping station in Buenos Aires be decorated like a royal palace, according to Dr. Jorge Tartarini, director of the museum located inside the gigantic metal tank. Šárka Jiroušková explained that even wastewater infrastructures were designed attractively, giving Prague as an example.
Professor Susan Ross showed us how Toronto first showed pride in its urban storage system, but then hid it away.
The water industry as world heritage, a publication supported by the European Commission (see www.waterheritage.com), was also presented at the conference.
This is the first comparative study on the historical infrastructure of the water industry, bringing together criteria to identify the most significant sites related to the water industry. It also presents twelve case studies from around the world, including a study on Barcelona by Dr. Manel Martín, the city's main historian specializing in water.
The questions raised at the conference (held in Cornellà) will be included in a report to be presented to Unesco in Paris. The report will aid in the selection of future sites for inclusion on the World Heritage List.

BESÒS POWER STATION, THE GREAT UNKNOWN

Besòs Power Station, which was also called the San Andrés de Palomar machinery house or the Besós elevator station, is a water pumping plant located in the Vallbona neighbourhood, north of Cerro de la Trinidad, on the right-hand side of the C-17 dual-carriageway (formerly Ribes road). The railway lines of the Granollers-Maçanet-France train line, and the AVE (high-speed train) run past it. The plant was installed near the syphon of the Dosrius aqueduct, which passes under the river, in order to extract water from its wells.
The power station, which still retains many of its splendid buildings, has played (and still plays) a very important role in supplying water to Barcelona. From the 1890s until 1909, when Cornellà Power Station was put into operation, it was the city's largest water supplier, but at the time it was relatively unknown. Other pumping stations such as those at Montcada, Trinidad (very close to Besòs Power Station), Cornellà, or Llobregat, have been restored and are now museums. The one at Besòs, however, has not even undergone a rigorous study, and information regarding its construction and subsequent extensions are inaccurate and contradictory.
Before Barcelona's city walls were demolished in the middle of the nineteenth century, most of the water that flowed into the city came from the Rec Comptal irrigation canal, and the rest came from the Collserola infiltration gallery and the city wells.
In the 1850s, Barcelona City Council decided to expand the city and planned a new neighbourhood called Eixample. This meant that finding a solution to the problem of the city's water supply became a priority.
Bear in mind that the city's wells were often located close to septic tanks as many streets did not have sewers. This resulted in a lack of clean drinking water, and epidemics were widespread.
In 1778, Barcelona City Council took the first decisive action, and in agreement with the irrigation association and other users of the Rec Comptal irrigation canal, built a filtering system under the Besòs river bed to increase the flow of the canal. in 1826, the Baix de Montcada aqueduct was inaugurated. This carried water for industrial and other uses directly from the infiltration gallery to the Pla de Barcelona without passing through the irrigation canal.

NEW CHALLENGES FOR THE PROVISION OF WATER

The need for water motivated both the Council and businessmen to seek a solution to the water supply issue. From 1870, the City Council proposed renovating the distribution network and the Casa de les Aigües de Montcada was inaugurated in 1878, with three drilled wells and pumps driven by steam engines.
In 1857, a company called Palau, García i Compañía was set up to capture subsoil water from the Dosrius basin in Argentona and direct it to Barcelona. Due to the lack of capital to continue the project, the company was taken over by the Compagnie des Eaux de Barcelone, set up in Liège in 1867 with capital from Belgium and France.

THE ORIGINS OF BESÒS POWER STATION

I have not been able to access the original documents from the Besòs power station building project, despite searching in the historical archives of the AGBAR Foundation, and other places. The difficulty in finding them is probably explained by the fact that the Compagnie des Eaux de Barcelone was based in Belgium, and so the documents could have been taken there for safekeeping.
The document I was able to with the most information about the origins of the plant is the Memoria sobre la instalaciones de la SGAB, an inventory published by the company 1925. A section of the inventory talks about the history of the power station, explaining that in June 1879, a water company founded in Liège in 1867 called Compagnie des Eaux de Barcelone had bought Palau, García & Compañía, which was already bringing water from Dosrius to Barcelona. This was how Compagnie des Eaux de Barcelone obtained the concession to extract water from the Besòs subsoil.
In 1882, a new company set up in Paris called Société Générale des Eaux de Barcelone acquired all the assets of the Compagnie des Eaux de Barcelone. Another document from the Société, dated 1885, tells us that in 1883 the new company obtained mining concessions for infiltration galleries which could extract up to 30,000 cubic meters of water. The project envisioned wells lined with cast iron and filtration holes. In order to obtain the necessary permit, the company gave the assurance that the amount of water extracted would not affect any wells or irrigation channels that were already active and, in addition, it committed itself to periodically checking them and taking action in the case that there should be a lack of water. In any case, the lawsuit taken out by the affected parties delayed the initiation of the works for several years.

AN ATTEMPT AT MUNICIPISATION

However, the Republican City Council, which had already acquired most of the private water companies, was about to push through a new proposal: the purchase of all SGAB facilities for 72 million pesetas, in cash.
In 1920, a group of Barcelona banks, together with the Bank of Bilbao, bought SGAB. The new owners bought it as investment capital and were not particularly interested in making the company profitable, so it was in their interest to transfer it quickly to Barcelona City Council. Eventually, however, differences in political and economic interests caused them to abort the project. From this moment on, the question of placing the water service under municipal ownership was not raised until 1936, when it was nationalised by Barcelona's

socialist government. After the Spanish Civil War, SGAB was returned to its old proprietors.
Besòs Power Station provided the city with a significant quantity of water (some 30,000 cubic meters per day) and functioned without interruption from 1909 to 1967, when water from the river Ter arrived. Besòs, together with the newly opened power station in Cornellà, were the largest suppliers of water to Barcelona by far.

FACILITIES AT THE BÈSOS POWER STATION

The buildings
The Besòs power station is made up of eight buildings. Construction on the machine room, which is the largest building, began in 1890 and the it became functional in 1892. The large 14 x 56 metre rectangular nave is a solid construction with brick pillars and stone wall enclosures.
The rectangular boiler house, which still exists today, was attached to the west side. It has two symmetrical sides and is covered with a pitched roof. Measuring 14 x 27 metres, it is constructed in a similar way to the largest building, but with the addition of large portals to facilitate access to the great coal-fired boilers and coal. The wrought iron doors and windows form a trellis of geometric patterns.
A large chimney sits about five meters to the north of the boiler room, and is still in good condition, except for the cap covering it.
The coal house was a large covered nave which sat between the boiler room and the railroad. Trapezoidal in shape, it was 28 meters long and between 16 and 10 meters wide. Today, only the outside wall still remains.
On the west face of the coal storage room, the small buildings used as workshops and workers' accommodation are in good condition.
A set of separate buildings sit across from the large boiler house. The largest, comprising three sections, contained a steam engine and turbine, the boiler house and a warehouse. Next to the boiler house, there is one chimney which is significantly lower than the one beside it. The other buildings were warehouses, with two wells in front of what remains of the most southern part.
Housing was in the northwest section and comprised a building with a pitched roof and two parts: one with two floors and the other only one floor.
There is also a remarkable building ten meters from the north face of the largest nave that does not appear on the 1912 plans. It housed the transformers when the power station was connected to the electrical grid.
The whole complex was surrounded by a walled enclosure, which protected the building from possible flooding, among other things. The 1912 plan shows the brick wall to be a trapezoid shaped, and between 100 and 130 meters long, most of which still exists today.

Mechanical installations
During the time that the City Council considered purchasing SGAB, The Water Supply Commission in Barcelona published a very complete report on the company's facilities in order to value the property. In the section on Besòs Power Station, the building complex and mechanical facilities are described in great detail.
The mechanical equipment that extracted the water from well number 1 was housed in the three-section building on the north face (mentioned above).
The report does not mention the machine's boilers, which at the time must have been missing or out of use. Consequently, when the document was drafted, the steam that fed the turbine came from the large boilers installed in the new building.
The large nave had two filtering wells, and water was extracted by means of single action double pistons and a submerged piston. This was driven by pistons moved by steam engines through rocker arms and connecting rods.
A large toolbox which was used to carry out maintenance work on the machines is on display at the AGBAR Water Museum
The gantry crane, which moved along the whole length of the nave on rails, is also very well preserved. The crane, with a lifting and transporting capacity of 38 tons, worked using chains and not with the existing steel cables, most probably because of the heavy weight they had to bear.

Functioning time of the machines
According to the information on the power station's monthly records, during the first decade of the 20th century, the machines worked whenever it was necessary, depending on needs and also the water level in the wells, which according to rain patterns, was usually between 10 and 16 meters. The two large machines could work 24 hours a day for days in a row, or only a few hours if necessary. They even stopped for a few days if there was insufficient water in the wells.

The move towards electricity
Until 1914, the electricity consumed in Barcelona came from the city's Vilanova and Mata thermal power stations. But in the same year, the first large hydroelectric power stations of Capdella and Serós came into operation, followed a short time later by those of Tremp (1916) and Camarasa (1918). These power stations provided the city with a much higher amount of electricity than that produced by power plants. This, together with the large increase in the price of coal and the difficulties obtaining it, made many companies change their energy system, moving from coal to electricity. In the case of Besòs Power Station, this occurred in the first half of 1914, when electric motors were installed. The power station's monthly records for February indicate that coal was consumed, while in July, the word 'coal' was scored out, and replaced by 'kilowatts'. Gradually, the system changed.

Besòs Power Station from the 1960s onwards
In 1962, a flood put the Trinitat Vella lift station (Aigües de Montcada) out of use, rendering it inactive for some months. In order to deal with such emergencies, the power station was connected to the main Besòs power station in 1964, before being finally closed in 1989.
Besòs power station was connected to the general water system of the river Ter in 1967. In the late 1980s, the water of the Besos aquifers became contaminated due to uncontrolled dumping by the large number of new industries which had sprung up along the Besòs Basin, and also wastewater from large urban agglomerations which had grown since the 1060s. Therefore, the power station stopped using water from its wells, as it had already done in Trinitat Vella.

The drinking water treatment plant (ETAP) at Besòs power station
One of the consequences of closing Besòs power station was that the freatic level of groundwaters rose. This caused serious problems at the lower part of the river delta as it caused flooding in underground areas of buildings (parking spaces, warehouses, etc.). This was one reason why it was decided to put the power station back into operation and go back to extracting and marketing the water. The other reason was an improvement in the quality of the water in the river Besòs due to new regulations controlling discharge of waste and a new sewage system.

HEALTH AND WATER SUPPLY

On the 150th anniversary of the Aigües de Barcelona company, and following a visit to the Montcada pumping station by the AMCTC, the idea arose to write an article examining the importance of water sanitation in improving living conditions. In Catalonia, and Barcelona in particular, there is a long history of hygienists and city planners who defended health policies addressing the longstanding deficiencies in hygiene conditions in the community.
Measures were gradually introduced to guarantee hygienic municipal water for consumption by the public. Improvements in both the physicochemical and microbiological quality of the water, amongst other factors, led to an improvement in living conditions in communities, especially in Barcelona.
Of all the water purification processes (filtration, flocculation, decantation, chlorination, ultraviolet treatment and with active carbon, oxidation, ultrafiltration and nanofiltration, reverse osmosis and remineralization), chlorine was the most decisive. Chlorine guaranteed the disinfection of drinking water, particularly from the year 1920, with automatic dosing devices that enabled homogeneous and adjustable concentrations of chlorine to be added to water.
In an article on the typhus epidemic in 1914 in the magazine *Medicina Socia*l, Dr. Xalabarder concludes that contaminated water is the most serious cause of illness. Water purification was not the only improvement, however. The general increase in water consumption meant that the domestic sphere (kitchens, communal wash houses, toilets, baths and showers) was better sanitized, and this was complemented by other sanitation measures such as eliminating wells, rainwater tanks and cess pits.
We can conclude that the epidemiological transition (a radical decrease in morbidity and mortality due to infectious diseases) was a key factor in the demographic transition (increase in life expectancy and reduction in mortality), and these two changes improved child development. disinfecting the water supply underlies this whole process.

THE INDUSTRIAL WATER HERITAGE IN BUENOS AIRES. LARGE DEPOSITS OF GRAVITATION

Among the old water supply systems, an impressive industrial heritage can be found in Buenos Aires. Here you can find large high-level storage tanks, which were built around 1900 and supplied the city with water. In the relatively flat city, the storage tanks held and distributed water extracted from the River Plate, which was drinkable in places close to the river banks. The tanks are testimony to storage techniques and drinking water distribution, and also the significance given to public hygiene at the time, beginning with the Palacio de las Aguas Corrientes (1894) and then with gravity tanks located in the districts of Caballito (1915) and Villa Devoto (1917), which are still in operation.
Around 1908, the city reached 1,025,650 inhabitants. A new sanitation project needed to be developed that could deal with the population growth and the requirements of "Radio Nuevo", the new outer district. The National Commission of Health Services decided to take on a vast health project. The work included a new extension to the Recoleta plant, two gravity tanks of similar size to the one at The Palace of Flowing Waters (*Palacio de aguas Corrientes*), the expansion of water networks and sewers and the construction of a new water purification plant, along with other work.
Two large gravity storage tanks, elevated to thirty-eight meters, were constructed on the outskirts of the capital. The Palace storage tank was thirty-five meters above the level of the River Plate.
The first to be built was the enormous Caballito storage tank. Its design followed the general principle of The Palace of Flowing Waters on Córdoba Avenue, that is to say, a large internal metal structure with twelve tanks, each with a 6,000 m3 capacity. It was set out on three levels and held by a grid of iron columns that also supported the frame covering the tank. The iron structure was imported from Great Britain, built by the Cleveland Bridge Co. Ltd., and the warehouse was constructed by Lavenás, Poli y Cía. Ways and Freytag S.A., carried out the building construction, while the distribution network was provided by Head Wrightson Co. Ltd. The wrought iron gates were purchased at Walter Macfarlane & Co. ironworks, Glasgow.
The architecture and engineering of Villa Devoto storage tank was similar to that of the Caballito one. Its large internal metal structure had twelve reserve tanks, each one four meters high and able to hold 6,000 m3 of water on three separate levels. The tank was supported by iron columns arranged in a grid formation, and this also supported the corrugated iron covering in the central part, and slate mansard roof.
The Palace of Flowing Waters is a unique work of its kind, both for its impressive interior iron structure, and its ornate façade with glazed terracotta tiling. Conceived as a great model to build, the project reached its final form in 1886 and it was constructed between 1887 and 1894, within the works laid out by the Water, Sewer and Storm Drainage Project for Buenos Aires. In 1869, it was the first city in Latin America to have a water purification plant.
Today, this landmark is an exceptional testimony to a time when advances in medical science and technology (steam) enabled governments to fight against the scourge of epidemics by undertaking large-scale health projects, unprecedented in this part of the world.
The gravity water storage tanks in Caballito and Villa Devoto districts illustrate how the iron industry had evolved at the time, and lent its skills to the manufacture of large water tanks, installing them in a distant location, part of the phenomenon of intercontinental transfer of products, techniques, materials and people from industrialized countries to the Americas.
Both storage tanks, which exemplify the technical and professional development achieved by local health organisations, show a high degree of authenticity and integrity, and enable an understanding of their purpose within the water storage and distribution system, both of their own system, as well as that of The Palace of Flowing Waters.