

## **COMPREHENSIVE UTILIZATION THROUGH TERTIARY TREATMENT IN THE CR ARCO SUR MAR MENOR VAL-509/16**

### **Authors:**

**Eloy Celdran Uriarte**, Arco Sur Irrigation Community.

**Manuel Latorre Carrión**, Desalia Water SL

### **Abstract**

The 'Arco Sur-Mar Menor' irrigation community has carried out a project for the utilization of regenerated wastewater from the Mar Menor Sur Wastewater Treatment Plant (EDAR), located in the municipal terms of Cartagena and La Unión.

This irrigation community consists of 149 members and an irrigable area of 1,528 hectares, of which 1,134 are dedicated to horticulture and 394 to citrus cultivation. The goal of the project to ensure the continuity of agricultural activity for its members and to carry out the project of utilizing regenerated wastewater from the EDAR to ensure the availability of water resources has been achieved through the installation of microfiltration membrane systems, both submerged and pressurized, followed by reverse osmosis treatment.

Additionally, a parallel network has been added to introduce groundwater from the members' saline wells and transport it to the desalination plant for reuse. The actions taken represent an example of water efficiency since not only is wastewater from the EDAR reused but also the drainage water from the community's fields.

## **INTRODUCTION**

The Arco Sur Mar Menor Irrigation Community is made up of the irrigable areas located between the Municipal Terms of Cartagena and La Unión, recognized by the CHS, with an irrigable area of 1,528 ha.

The region known as the Arco Sur of Mar Menor is located, as its name suggests, in the southern part of the Mar Menor in the Autonomous Community of Murcia and includes part of the Municipal Terms of La Unión and Cartagena, in the Southeast of Spain.

The original project was approved by the Segura Hydrographic Confederation on July 25, 2003, for the utilization of treated wastewater from the Mar Menor Sur WWTP (Murcia). Subsequently, in 2007, the expansion of the desalination plant was initiated, and it was planned to use the volumes coming from the extraction of the currently saline wells of the members and the volumes from the surface drains of the irrigation waters in the influence area of the Arco Sur Mar Menor Irrigation Community.

## **PROJECT OBJECTIVES**

Due to the lack of water resources in southeastern Spain and more specifically in the eastern part of the Campo de Cartagena, the CR Arco Sur has launched a project to utilize wastewater, agricultural drainage, and previously discarded saline water for irrigation. The raw water to be treated at the Desalination Plant comes from three different sources:

1. Water from the secondary treatment of the Mar Menor Sur WWTP, currently in operation, and originally destined for direct discharge into the Mediterranean through an underwater outfall. The estimated annual volume treated by the WWTP, once all the corresponding population centers are connected, is approximately 3.5 Hm<sup>3</sup>.
2. Well water from the concessions currently available to the members of the CR Arco Sur Mar Menor. According to the Hydrogeological Study for the collection of saline groundwater to complement the water from the Mar Manor Sur WWTP, the maximum volume to be supplied by the coastal wells is 5 Hm<sup>3</sup>.
3. Drainage network from the southern Mar Menor, which currently discharges underground into the same area. The expected volume from this source, which can be treated by the desalination plant, is 5 Hm<sup>3</sup>.

Considering the total raw water available to be treated by the Desalination Plant (13.5 Hm<sup>3</sup>) and the process yields of Ultrafiltration and Reverse Osmosis, the maximum production capacity is 9.70 Hm<sup>3</sup> of permeated water per year.



**Characteristics of the water to be treated.**

Depending on the source of the raw water to be treated, the characteristics of the water at the beginning of tertiary treatment are different, as shown in the following table:

Parametro		EDAR M.M. SUR	POZOS	DRENAJES
DQO	mg/l.	60,5		
S.S.	mg/l.	3,33		
pH		7,5	8,2	
Fosfatos	mg/l.	2,97	3,6	
Coliformes fecales		10 <sup>5</sup> col/10 cc.	--	--
Conductividad	μS/cm	9000	1200-7150	2500-8600

### Characteristics of the treated water.

The effluent from the tertiary treatment has the following characteristics:

Parámetro	Concentración
DBO <sub>5</sub>	< 10 mg/l.
S.S.	< 5 mg/l.
pH	6,5 – 9,5
Turbidez	< 0,5 NTU.
Coliformes fecales	200 col/10 cc
TDS	< 450 ppm

### TREATMENT PROCESS.

The proposed solution consists of a desalination process using double-pass single-stage reverse osmosis, with pretreatment, as the water comes from wells and drains. The pretreatment is limited to fine filtration using cartridge filters.

This pretreatment is preceded by coarse filtration using a static screen. The plant's capacity will be 14,000 m<sup>3</sup>/day of product water, divided into four (4) lines of 3,500 m<sup>3</sup>/day each. In the first phase, the equipment for two racks will be installed, with a production of 7,000 m<sup>3</sup>/day (2.45 Hm<sup>3</sup>/year), and the installation will have the necessary connections for future expansion.

TRATAMIENTO TERCIARIO EDAR MAR MENOR SUR					
Resumen Características					
FASE		1ª	2ª	3ª	4ª
PRODUCCIÓN ANUAL	Hm3	2,45	4.90	7,30	9,70
PRODUCCIÓN DIARIA	m3/d	7.000	14.000	21.000	28.000
AGUA BRUTA TOTAL	Hm3	3,60	7,20	10,40	13.60
AGUA BRUTA	m3/d	10.285	20.741	31.111	37.500
CONVERSIÓN GLOBAL	%	68	68	75	75
Nº DE BASTIDORES		2	4	6	8
CAPACIDAD BASTIDOR	m3/d	3500	3500	3500	3500

- Pretreatment through submerged ultrafiltration with 4 sets of two cassettes each, with 55 hollow fiber membrane modules Zeewed 1000 GE ZENON for a total flow of 400 m<sup>3</sup>/h.
- Pretreatment through pressurized Ultrafiltration with 6 racks, each containing 60 membrane modules, manufactured by NORIT PENTAIR Model X flow Aquaflex 55, for a total flow of 1200 m<sup>3</sup>/h.
- The pressurized ultrafiltration pretreatment is equipped with a ring filter battery with a 100-micron cutting capacity.
- Raw water is pumped using 8 horizontal centrifugal pumps made of AISI 316, with an individual flow rate of 216 m<sup>3</sup>/h at 50 mca. They are equipped with a frequency converter to adjust the suction pressure based on the water temperature and the degree of fouling of the osmosis membranes and cartridge filters.
- Dispersant dosing. Its purpose is to prevent salt precipitation that could lead to membrane fouling.
- Cartridge filters. 8 cartridge filters are included, two per line, each equipped with 35 filtering cartridges, each 1,250 mm long and 5 microns in selectivity.
- In order to prevent the presence of oxidizing agents that could affect the membranes, sodium bisulphite dosing will be carried out.
- High-pressure pumping consists of 8 units for pumping pre-treated water to the osmosis lines, each with two stages. Using the high-pressure pumps, the outlet pressure of the cartridge filters is raised by 144 mca, ensuring that the 194.45 m<sup>3</sup>/h feeds the osmosis membranes at a variable pressure ranging from 13.60 bar (28°C FF:1) to 17.58 bar (16°C FF:0.7). This pressure variation is achieved by adjusting the frequency converter of the feeding pumps.
- The reject water from the first stage (94.39 m<sup>3</sup>/h at 16°C and FF:0.7) is drawn by a booster that raises its pressure to 22.59 bar (an increase of 7.2 bar) and supplies the second stage in forward motion. This booster is connected to a recovery turbine powered by the reject water from the second stage (45.78 m<sup>3</sup>/h) with a usable pressure of 21.14 bar.
- Brackish water reverse osmosis racks consisting of 8 racks of reverse osmosis with a nominal unit production of 3,500 m<sup>3</sup>/day, resulting in a total production of desalinated water of 28,000 m<sup>3</sup>/day. Each of the racks has two stages. The first stage has 22 pressure tubes, and the second stage has 11 pressure tubes. Each pressure tube has 7 spiral-type membranes. The operational conversion is 75%.
- Each of the brackish water racks is equipped with an osmotic equilibrium tank with an individual volume of 5 m<sup>3</sup>.

- For the conditioning of the product water, the addition of calcium hydroxide has been planned for pH adjustment.
- The treated water is pumped back to the WWTP (Wastewater Treatment Plant) using pumps with a flow rate of 292 m<sup>3</sup>/h at a head of 18 m.c.a., through a 400 mm diameter PEAD (High-Density Polyethylene) collector, to the current treated water storage tank at the WWTP. There, it is mixed with the purified water in the appropriate proportion and sent to the irrigation system.
- Membrane cleaning equipment and displacement pumps installed in the previous phases, as well as complete water and air service installations.
- From the neutralization tank, the water overflows into the final storage and pumping tank. In this tank, the neutralized cleaning waters are mixed with the osmosis reject brine and pumped towards the WWTP's underwater outfall. For this purpose, two horizontal centrifugal pumps with a flow rate of 145 m<sup>3</sup>/h each, at a head of 15 mca, are used through a 250 mm diameter PEAD collector.

The product water is sent to a 10,000 m<sup>3</sup> capacity storage reservoir from where it is distributed to serve the approximately 1800 hectares that make up the Irrigators' Community.

As distinctive features of the plant, apart from advanced production management, the distribution is carried out by responding to scheduled requests for water supply to farmers' hydrants. This is combined with the planning of the supply of raw water based on the source of supply and the pumping to reservoirs located at optimal elevations within the distribution network.

Regarding the integral resource utilization, even the condensation water from air conditioning equipment in the summer is reused, as well as the condensation from the process area roof in the winter for watering gardens and embankments. Additionally, losses due to evaporation have been minimized by covering the product water reservoir with a PEAD (High-Density Polyethylene) sheet. This ensures that the Irrigators' Community Arco Sur utilizes every last drop of water available in its facilities.

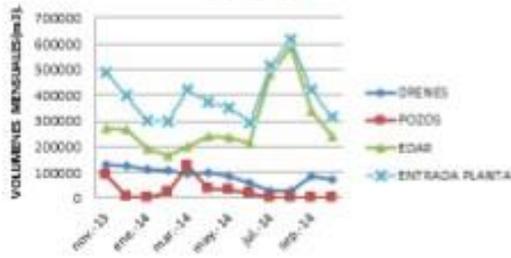
The graphs of desalinated water production and the quality of the raw water supply sources for the last few years are shown below.

		VOLUMENES MENSUALES AGUA BRUTA											
ENTRADA		nov-13	dic-13	ene-14	feb-14	mar-14	abr-14	may-14	jun-14	jul-14	ago-14	sep-14	oct-14
DRENEZ		130973	125218	112130	208558	95714	98189	85572	80900	38281	29123	83855	75244
POZOS		89674	6013	0	25189	126081	35343	21319	21059	2116	0	0	0
EDAR		289788	288084	180703	187117	199525	238439	238305	214047	484789	588875	538751	241188
ENTRADA PLANTA		490435	399903	302842	298858	421320	372981	355196	296009	515187	615998	422586	316410

		VOLUMENES MENSUALES ACUMULADOS AGUA BRUTA											
ENTRADA		nov-13	dic-13	ene-14	feb-14	mar-14	abr-14	may-14	jun-14	jul-14	ago-14	sep-14	oct-14
DRENEZ ACUMULADO		130973	256191	368320	474896	570610	668809	754381	813284	843566	872689	956544	1029788
POZOS ACUMULADO		89674	95887	95887	120870	246951	282294	313613	334672	355788	355788	355788	355788
EDAR ACUMULADO		289788	537850	718553	895670	1095195	1333634	1570939	1784986	2269775	2858650	3195381	3436547
ENTRADA PLANTA ACUMULADO		490435	888736	1191578	1491436	1812756	2185737	2538833	2834942	3450129	4066127	4488713	4803123

**GRAFICA DE VOLUMENES MENSUALES DE ENTRADA DE AGUA BRUTA.**



**GRAFICA DE VOLUMENES MENSUALES ACUMULADOS DE ENTRADA AGUA BRUTA.**



		VOLUMENES MENSUALES AGUA DESALADA											
ENTRADA		nov-13	dic-13	ene-14	feb-14	mar-14	abr-14	may-14	jun-14	jul-14	ago-14	sep-14	oct-14
AGUA DESALADA		285412	280379	321373	288868	282347	313007	311452	244448	360428	453634	389487	218812

		VOLUMENES MENSUALES ACUMULADOS AGUA DESALADA											
ENTRADA		nov-13	dic-13	ene-14	feb-14	mar-14	abr-14	may-14	jun-14	jul-14	ago-14	sep-14	oct-14
AGUA DESALADA		285412	565791	747164	967972	1249919	1562926	1874378	2118827	2479255	2932889	3220776	3439588

**GRAFICA DE VOLUMENES MENSUALES DE AGUA DESALADA**

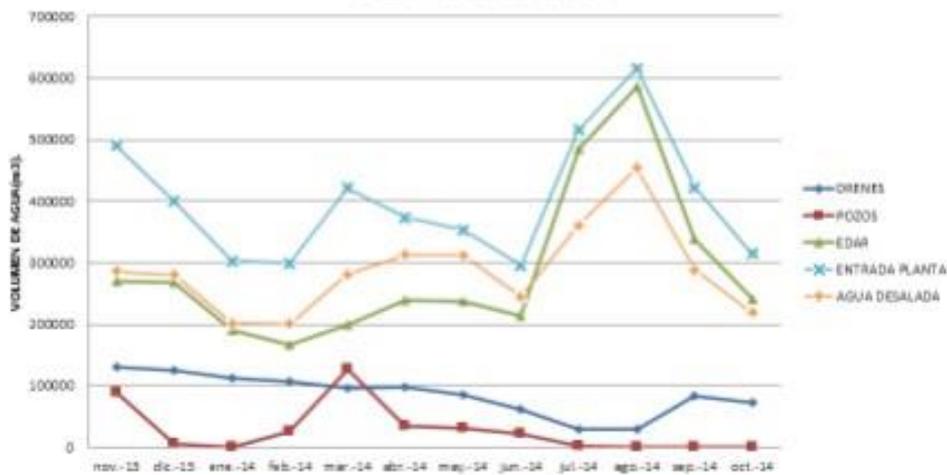


**GRAFICA DE VOLUMENES MENSUALES ACUMULADOS DE AGUA DESALADA**



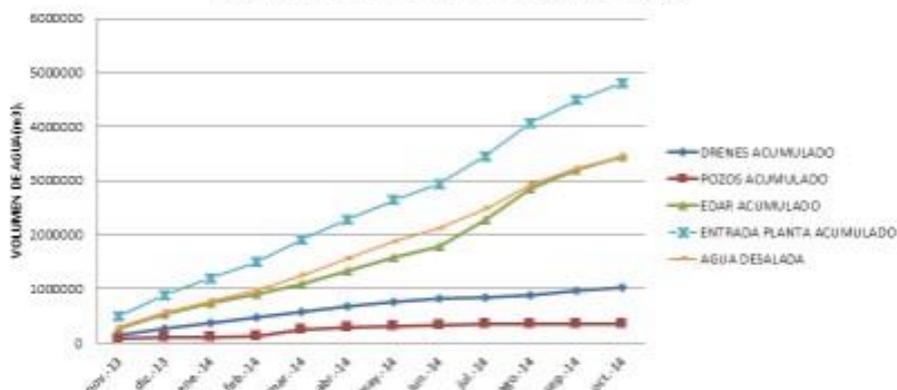
VOLUMENES MENSUALES AGUA												
ENTRADA	nov-13	dic-13	ene-14	feb-14	mar-14	abr-14	may-14	jun-14	jul-14	ago-14	sep-14	oct-14
DRENS	120873	135206	112120	100000	88714	90290	85670	60903	28282	28123	83856	72244
POZOS	28674	6012	0	25182	10000	20242	21210	21059	2116	0	0	0
EDAR	289788	280084	120700	187127	209520	228429	238308	214047	484789	568879	558751	241168
ENTRADA PLANTA	490423	399303	202842	296808	421520	372963	383296	299009	518187	610904	421588	314410
AGUA DESALADA	18142	280379	101275	200808	281247	113007	111482	244449	380428	483854	289487	218812

### VOLUMENES DE AGUA



VOLUMENES MENSUALES ACUMULADOS												
ENTRADA	nov-13	dic-13	ene-14	feb-14	mar-14	abr-14	may-14	jun-14	jul-14	ago-14	sep-14	oct-14
DRENS ACUMULADO	132873	268079	380199	478199	576913	667203	752873	823776	852060	879949	888393	1029788
POZOS ACUMULADO	28674	34686	34686	119868	129868	149868	169868	189868	191984	191984	191984	191984
EDAR ACUMULADO	289788	569872	690572	877700	1087220	1315649	1553957	1768004	2252793	2821672	3380423	3621591
ENTRADA PLANTA ACUMULADO	490423	889726	1092568	1489376	1911336	2284300	2667596	2966605	3484792	4095696	4517284	4831694
AGUA DESALADA	18142	298521	399796	601004	714011	827018	940025	1053032	1217460	1396904	1586391	1785203

### VOLUMENES MENSUALES ACUMULADOS



VALORES MEDIOS MENSUALES DE CONDUCTIVIDAD												
PUNTO DE MEDIDA DE LA CONDUCTIVIDAD	nov-13	dic-13	ene-14	feb-14	mar-14	abr-14	may-14	jun-14	jul-14	ago-14	sep-14	oct-14
DRENAJES-POZOS EN DEPÓSITO REGULADOR	12,22	13,10	13,76	14,32	12,23	13,65	14,77	14,87	16,21	17,66	15,35	15,91
PLANTA DESALADORA	11,10	10,28	12,06	13,76	9,97	10,75	11,25	11,95	7,50	6,07	10,46	13,35
SALIDA EDAR	11,28	9,25	10,17	11,05	7,85	9,27	10,4	9,03	6,68	4,9	8,43	11,4



## CONCLUSIONS

- The reuse facilities of CR Arco Sur Mar Menor serve as an example of comprehensive utilization of the secondary effluent from the Cabo de Palos wastewater treatment plant, which was previously discharged directly into the Mediterranean, reusing an approximate annual flow of nearly 10 Hm<sup>3</sup>.
- In the same location, two technologies of submerged and pressurized microfiltration are installed, along with a double-stage desalination process with an intermediate booster, resulting in high-quality water suitable for irrigation.
- The management of the desalination plant has successfully addressed the challenges posed by having three different sources of raw water: the secondary effluent of the wastewater treatment plant, the irrigation drains, and the saline wells. It adapts to the variations in demand based on the seasonality of the crops.