Deliverable B2.1 Technical detailed document of the disinfection unit;

Deliverable B2.3 Technical detailed document of the pilot system;

Deliverable B2.4 Technical detailed document of the purification unit

Action	B.2	Pilot plant design of the integrated system for water reuse and recycling
Dissemination level[1]		
Nature[2]		
Due delivery date	01/2016	
Actual delivery date	09/2016	
Number of pages	28	

Lead beneficiary	RITEC
Contributing beneficiaries	

Document Version	Date	Author(s)	Comments
1	24/08/2016	Francisco Sánchez Millán	

Acknowledgement:

This deliverable was produced under the co-finance of the European financial instrument for the Environment (LIFE) programme during the implementation of the project "LIFE DRAINUSE" (LIFE14 ENV/ES/000538).

[1] Dissemination level: **PU** = Public, **PP** = Restricted to other programme participants, **RE** = Restricted to a group specified by the consortium, **CO** = Confidential, only for members of the consortium.
[2] Nature of the deliverable: **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other.

Deliverable abstract

The installation can be divided in three different subsystems: Osmosis, Irrigation and Disinfection. Each subsystem has different specifics objectives and a functional description. In the document, there is also a point about calculations of the different elements of the plant and technical specifications. At the end there is a paragraph about conclusions in the design phase and a P&ID diagram.

List of acronyms and abbreviations:

EC - Electrical Conductivity

UV - Ultraviolet

PLC - Programmable Logic Controller

T - Temperature

PT - Pressure Transmitter

LS - Limit Switch

List of contents

1. Project overview

The use of a full recirculation water system for irrigation will have the following impact in the society:

- They will have the possibility of transforming their facilities into a closed system by simply implementing the recirculation unit that is demonstrated in this project. This will increase the profitability of their businesses.
- The implementation of closed systems in greenhouses will reduced the environmental impact of the agricultural activity, which will increase their quality of life by allowing access to a cleaner a safer environment.
- The reduction in the environmental pollution by the implementation of closed systems will contribute to the conservation of areas of touristic interests such as rivers, coast zones and lakes.

In this document is defined the process, the equipments, instrumentation, all the elements and its distribution, required to irrigate with low quality water reusing all the drainage water.

2. Document objectives

To demonstrate the feasibility of using a full re-circulation system for soilless culture in the Euro-Mediterranean region.

The aim of the project will be achieved through the next specific objectives:

- To demonstrate through the design, construction and set up of a full re-circulation pilot system the technological possibility for Euro-Mediterranean regions of drainage reuse. The pilot system will be tested in tomato plants, one of the most economically important and extended crop in south Europe.

The pilot system proposed here will be able to collect the drainages coming from the normal irrigation of the tomato plantation, to disinfect them and to adjust the nutrient concentration, pH and electrical conductivity with the purpose of making drainages re-usable for a new irrigation cycle.

- To propose a legal and regulatory framework for drainage recirculation to Euro-Mediterranean regulatory bodies

- To disseminate to all interested stakeholders, the benefits of full recirculation systems as an environmental friendly solution for drainage release of hydroponic greenhouses.

3. Process Description

The process is based on an Irrigation Plant that takes low quality water from a reservoir, treats this water using an Osmosis System, making different nutritive solutions according to pH and EC values and purifies the collected drainage with and UV System, creating a closed loop for the irrigation water.

Basically the process can be divided in three different subsystems composed by:

- An Osmosis Plant that takes water from a reservoir to supply treated water to the fertilizers tanks and also to the tank with the nutritive solution.

- An Irrigation System controlled by a PLC that prepares the nutritive solution with the required concentration of fertilizers and acid, according to the set points established of EC and pH.
- A disinfection unit that stores the drainage to be treated with a UV equipment. This drainage treated water is also stored to be analysed and finally, if the quality of this water is according to the specifications, is sent back to the tank with the nutritive solution.

4. Osmosis System

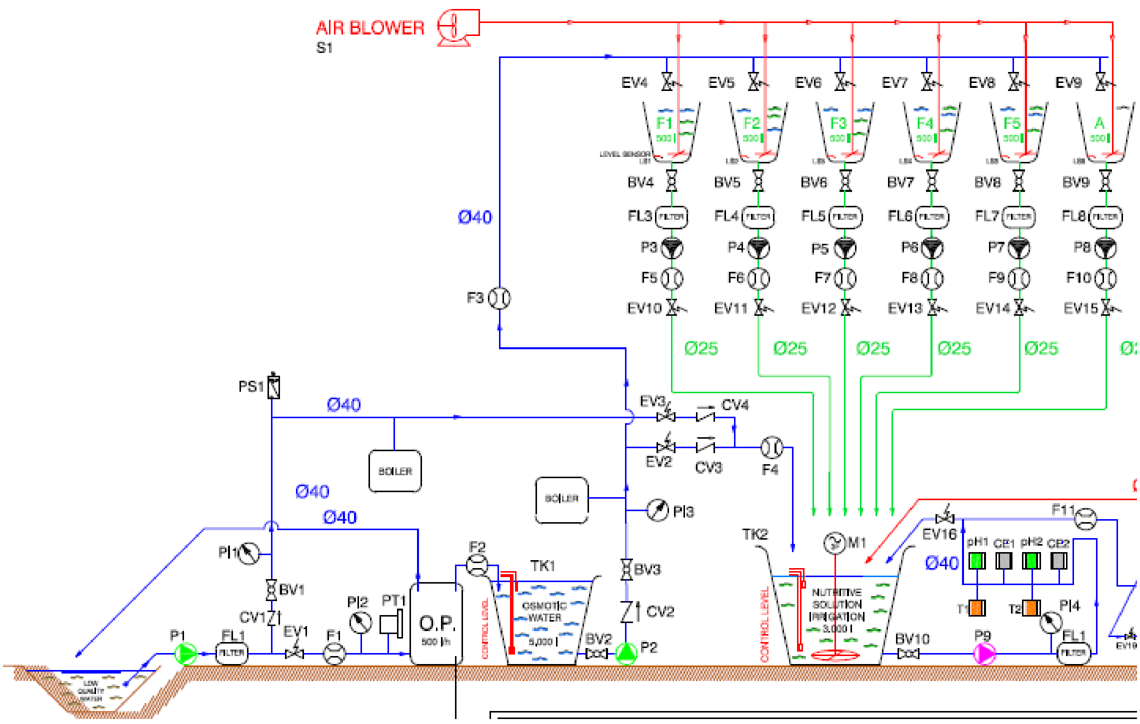
4.1. Objectives

- To use low quality water from a reservoir for irrigation through a reverse osmosis system that disinfect the water and supply the fertilizers tanks.

4.2. General Description

In the Osmosis System (invoice 1/924), the water is pumped (invoice 1/855) from a raw water tank to the Osmosis Plant. The water product is stored in an osmosed water tank with level control. The quantity of osmosed water and the rejection are measured by two water meters.

In the following picture is showed this part of the process:



Picture 1: Osmosis Process.

The EC values are measured at the beginning and the end of the process (invoice 1/918).

It is add flocculant, with an optimum chlorine quantity, to increase the efficiency of the process.

In the Osmosis Plant the water goes throw activated glass, carbon and cartridge filters before going pumped to the membrane.

In the activated glass are retained particles up to 10 microns. That filter is loaded electrically, bio resistant and minimizes the biofouling.

The carbon filter purifies the water. The carbon retains oil, fats, toxins, and other components that produces colour.

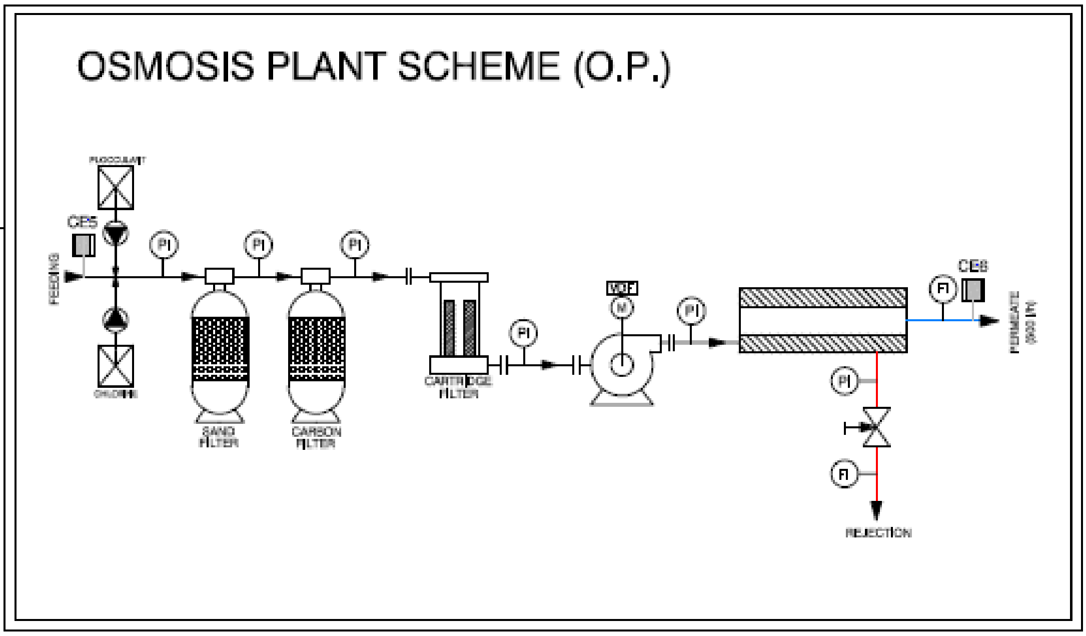
As a consequence of a differential pressure, the liquid flows throw the cartridge leaving all the contaminants inside.

Finally the filtrated water is pumped to the membranes where the salts are retained.

In reverse osmosis, an applied pressure is used to overcome osmotic pressure, a colligative attribute, that is driven by chemical potential differences of the solvent, a thermodynamic parameter. Reverse osmosis can remove many types of dissolved and suspended species from water, including bacteria. The result is that the solute is retained on the pressurized side of the membrane and the pure solvent is allowed to pass to the other side. To be "selective", this membrane do not allow large molecules or ions through the pores (holes), but allow smaller components of the solution (such as solvent molecules) to pass freely.

4.3. Process Description

In the following picture is showed the whole Osmosis process:



Picture 2: Osmosis Plant Scheme.

The feed water should be directed to the entrance point of the plant. The feed water pressure to the plant must be from 3 to 4 bars in any circumstances for a good performance.
Once driven into the plant, it's subjected to the feed water to a thorough pretreatment before it reaches the osmosis membranes. This pretreatment is to avoid damages to the membrane, through removal undesirable substances present in the feed water and adjusting their chemical parameters.
The chemical pretreatment that is done to the feed water are:

- Sodium Hypochlorite dosage for organic material´s oxidation.
- Flocculants dosage, in case is necessary, to improve filtration

- Inhibition Calcium sulfate precipitation, strontium and barium by dosing a dispersant (depends on the characteristics of the dispersant, sometimes also it inhibits the precipitation of carbonate, iron and silica).

The physical treatment it aims to eliminate any undesirable substances that may exist in the feed water. The physical treatment consists of:

- Filtration phase active crystals, the filter should be washed periodically to remove particles that have been retained in normal operation. Detecting the need it´s performed by reading the differential pressure input and output filter. It´s done by feed water pumped countercurrent.
- Filtration phase active Carbon, for the elimination of residual hypochlorite and reduce the organic material. The sand filter should be washed periodically to remove particles that have been retained in normal operation. Detecting the need it´s performed by reading the differential pressure input and output filter. It´s done by feed water pumped countercurrent.
- Microfiltration phase with polypropylene cartridges selectivity micron. The need to change the cartridge microfiltration unit, it´s performed by reading the water´s differential pressure passing though the unit.

Once done the physical-chemical pretreatment, conditioned feed water is directed to the Pumped Unit high pressure. This unit consists of a centrifugal pump unit type multiphase, which drives the water to the reverse osmosis unit.
To avoid damage to the high pressure bomb by pressure drop, a low pressure switch will be installed at the entrance of the high pressure pump which automatically stops the system below the design pressure.
The reverse osmosis unit it´s form by four pipes, Pressure pipe with a total of four membrane elements. Each pressure pipe has an entrance and two exits (one for the treat water and the other for rejection).
Treat water should be direct towards a deposit of about 125 liter to be used later.
With this deposit located at the exit of the desalination plant is able to maintain treat water storage, which aims:

- Automatically eliminate rejection, diluted with well water from the existing in the pressure pipes, when the stops are made (flushing system)

Water available for potential chemical cleaning of the membranes

The osmosed water is pumped to supply to the fertilisers tanks and also to the tank with the nutritive solution. The raw water could be pumped directly to the nutritive solution tank if it is required.

The pumps for the raw and the osmosed water have pressure control to work an autonomous way and have sensors to protect the pumps (invoice 1/855).

The whole process is controlled by a PLC that sends digital inputs to the electrical valves and to the pumps.

5. Irrigation System

5.1. Objectives

- To create different nutritive solutions for Hydroponic System using water from an Osmosis Plant and the treated drainage that is added in the main nutritive solution tank.

5.2. Description

In the Irrigation System it is prepared the nutritive solution to irrigate the crop. There are six fertilizers tanks and one tank for Acid, all of them with a volume of 500 L (invoice 1/864). These tanks are agitated by air (invoice 1634949), gets the water from the osmosed water tank and supply nutrients to the nutritive solution tank.

The quantity of osmosed water is controlled by an PLC that sends the signal to the electrical valves placed in the admissions of the fertilizers tanks.

Each fertilizer tank has an injection unit in the discharge. The injection unit is composed by:

- Ball valve.
- Filter.
- Magnetic monophasic pump.
- Flow meter.
- Electrical valve.

The PLC controls the nutritive solution based on the EC, pH and T measured on the impulsion pipe of the pump that irrigates the crop, taking the nutritive solution from the tank. To assure that the measured values are taken correctly, are installed two EC and pH sensors. Those sensors are electrically supplied (12 Vcc) by a transmitter (invoice 1/892) that returns the pH and EC signals to the PLC with 4-20 mA protocol. To get the set points of these physical magnitudes in the Nutritive Solution Tank, the controller acts on the electrical valves and the magnetic pumps, placed on the discharge of each fertilizer tank.

To accelerate the response of the electrical valves, will be installed to small drum pressurized tanks (invoice 1/958) that supplied water to these valves.

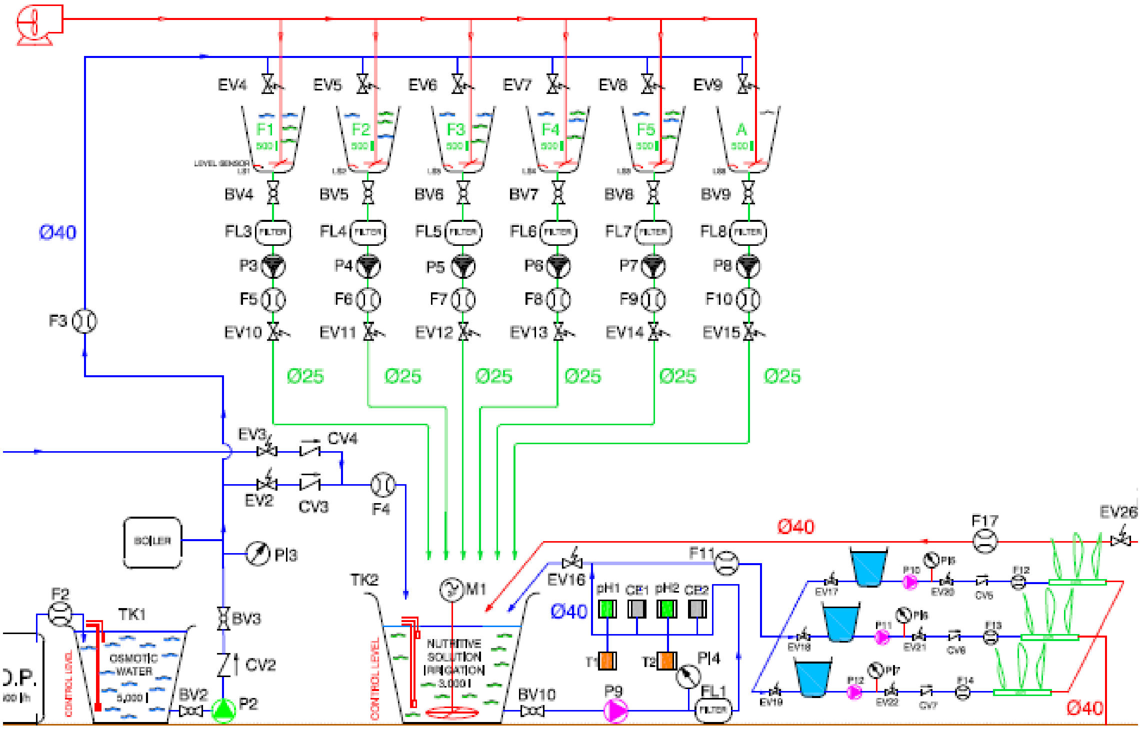
The nutritive solution is mixed in the Nutritive Solution Tank by an electromechanical stirrer (invoice 1/929). This tank has level controls to assure that the irrigation pump works properly.

To work with different nutritive solutions, will be installed three intermediate tanks. Depending on the nutritive solution prepared, this irrigation solution will be pumped to one of the intermediate tanks. This way, there will be three different nutritive solutions to make trials.

Finally, from one of the intermediate tank, the nutritive solution is pumped to irrigate the crop during five minutes, several times with an estimated flow of 3000 l/h.

All the flows are measured by flow meters that provides digital inputs to the PLC calibrated to 1 pulse = 0,1 L;

In the following picture is showed the part of the process relative to the Irrigation System:



Picture 3: Irrigation System.

6. Disinfection System

6.1. Objectives

- To reuse all the drainage water collected using an UV System and feeding the main nutritive solution tank creating a close circuit for the irrigation water.

6.2. Description

The drainage collected from the irrigation is measured by a flow meter. This kind of sensor provides a signal to the PLC, where each digital input is calibrated to 0,1 l. This untreated drainage water is collected in a tank with a capacity of 1000 L. The water is pumped and pre-filtered to remove impurities of every nature and consistence. After that, the filtered water is conducted throw a UV Unit (invoice 1/416) where the water is disinfected. UV disinfection is an effective method to eliminate pathogens in water without leaving toxic residues. The optimal dose of UV has been determined to reduce the microbial load to values standard for irrigation of vegetables for human consumption.

The UV light given out by special mercury lamps (UV-C rays λ= 254 nm) is highly germicidal because it interacts with DNA and RNA, at a molecular level. The deep bio-structural disorder caused by such irradiation interferes with the development and the ability of reproduction of every kind of micro-organism, making it harmless.

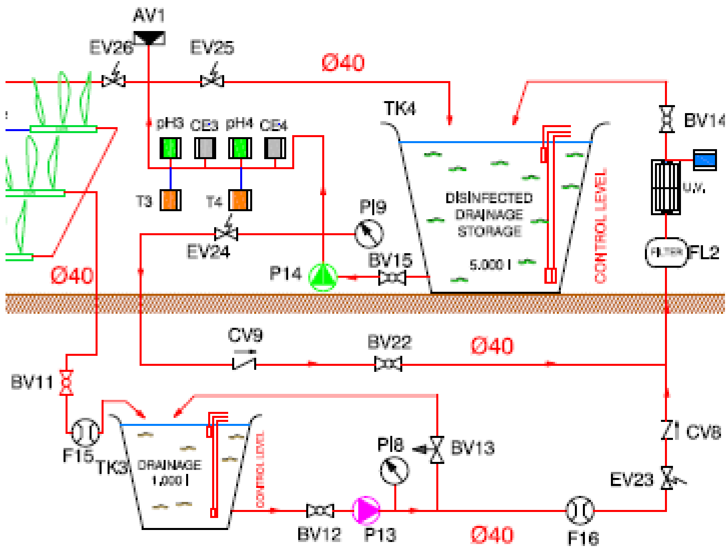
This system provides a high degree of disinfection, in fact the non-filtration and removal of suspended particles in the water has, as a consequence, a decrease of the disinfection system's efficiency.

The disinfected water is stored in a 5000l tank with control level, where the quality of this water is analysed. If the water`s quality is under the standards to irrigate vegetables, the drainage water is pumped to the UV unit again. When the water`s quality is according to the specifications, this water is pumped to the Nutritive Solution Tank.

The disinfected water is measured by a water meter. The EC, pH and T are measured on the impulsion pipe of the pump that sends back the water to the Nutritive Solution Tank.

This way, there is a full re-circulation system for soilless crop.

In the following picture is showed the part of the process relative to the Disinfection System:



Picture 4: Disinfection System.

7. Calculations

7.1. Osmosis Plant

The osmosis plant type HRO 20 P will produce 15 m3/day of low conductivity water. The function of this plant is the treatment of low quality water from a reservoir to create water with low salinity.

It will need special attention the biological quality of the water. This water is superficial and it is exposed to variations that can complicate the operation of the plant.

The performance proposed it´s an estimation, which can change the conversion of the plant in function of the conditions of feed water. If appears colloids or turbidity, it will be necessary other treatments that are not included in this plant.

Water in good condition both physical and biological is considered for a good performance of the osmosis system.

➢ ***Design Parameters***

1. Performances information

Water source: **Well water**

Design temperature: **20°C**
Plant`s conversion: **60%**
Operating pressure at 2 years: **10 bar**

	Feed Water	Treat water
Water Flow :	20 m^3/d	**12 m^3/d**
Conductivity (µS/cm):	1.000-2.500 µS/cm.	**< 30-150 µS/cm.**
pH:	7'5	6'4

Performance:	Continuous or intermittent
Operating mode:	Manual or automatic
Protection:	Automatic

2. Feed water analysis estimated

Conductivity	1.000-2.500	µS/cm

3. Maximum allowable concentrations of harmful substances

SDI NTU	<3	% 15 min.
TSS	<1	
SiO_2 (reactive)	0	mg/l
Al	0.05	mg/l
Fe	0,01	mg/l
Mn	0,01	mg/l
Ba	0,001	mg/l
Sr	0,001	mg/l
Oil or fat	0	mg/l
Bacterial contamination	Nula	
DBO, DQO	<5	mg/l

- Filtration Calculation

Feed Flow	20	m3/day
	0,83	m3/h
Recirculation Flow	1,22	m3/h
Glasses Filter		
Diameter	355	mm
Heigh	1650	mm
Volume	140	litros
Area	0,10	m2
Lineal speed	8,42	m/h
Bed heigh	1'17	m
Glass load	140	Kg
Coal Filter		
Diameter	330	mm
Heigh	1370	mm
Volume	103	l

Area	0,09	m2
Lineal Speed	9,75	m/h
Bed heigh	0'9	m
Coal Load	70	litros
Contact time	5,04	minutes

Cartidge filter

Lenght	20	"
Speed	0,61	m/h.10"

➢ ***Membrane calculation***

Reference: 165654 Case: 01 Date: 23/05/2016

Project Title: Ritec, 12 m³/day

1. Reverse Osmosis information

Water Type	Brackish surface
Feed temp.	20, 00 (design)
Feed pressure net	10, 83 bar after 3 years
Differential pressure	0, 25 bar ()
Rejection pressure	10, 25 bar before control valves
Design Period	3, 00 years
Fouling resistance	0, 81 after 3 years, estimated
Salt pass increase	52, 00% after 3 years, 15% per year estimated
Block index	4, 00 reverse osmosis feed (SDI_15)
Total conversion	60%
Feed flow	20, 00 m³/d=0, 86 m³/h
Treat Flow	12, 00 m³/d= 0, 50 m³/h
Flux middle system	0, 45 m/d = 18, 68 1/m²/h = 11, 01 GFD
Rejection flow	8, 00 m³/d =0, 33 m³/h
Feed salinity	1778, 14 ppm ion
Treat salinity	15, 04 ppm ion after 3 years, estimated 4422, 44 ppm ion
Rejection recirculation	
Intern conversion	40, 98%
Reserves Osmosis (RO) Feed	29, 28 m³/d = 1, 22 m³/h
RO Rejection flow	17, 28 m³/d= 0, 72 m³/h
Recirculation rejection flow	9, 28 m³/d =0, 39 m³/h

2. Information

RO type elements	TML10
RO no. elements	4

Elements/box	4	
Pressure box	No.	1

Conversion	%	40, 98
Feed	m³/d	29, 28
Treat	m³/d	12, 00
Middle flux	1/m²/h	18, 68
Rejection flow	m³/d	17, 28

Feed pressure	bar	10, 83
Elements DP	bar	0, 25
Collectors DP	bar	0, 00
Rejection pressure	bar	10, 58
Treated water	bar	0, 00

1st element		
Feed	m³/d	29, 28
Treat	m³/d	3, 20
Flux	1/m²/h	19, 95

Last element		
Treat	m³/d	2, 77
Treat: Reject	1:	6, 23
Rejection	m³/d	17, 28
Net pressure	bar	6, 24

3. Analysis

Analysis ppm ion	*Feed source*	*Feed entrance*	*Reject Conc.*	*Treat water expected*
Calcium	150, 00	150, 00	373, 98	0, 68
Magnesium	100, 00	100, 00	249, 32	0,45
Sodium	300, 00	300, 00	744, 47	3, 69
Potassium	10, 00	10, 00	24, 75	0, 17
Chloride	617, 61	617, 61	1535, 90	5, 41
Sulfate	400, 00	400, 00	997, 66	1, 56
Nitrate	50, 00	50, 00	123, 33	1, 11
Bicarbonate	150, 00	149, 87	368, 75	2, 01
Carbonate	0, 53	0, 52	2, 97	0, 00
Free CO2	4, 46	4, 56	5, 62	4, 57
Ion Total	1778, 14	1778, 07	4422, 44	15, 04
Meq Total	29, 02	29, 02	72, 19	0, 23
EC uS/cm	2537, 68	2537,62	5846, 59	24, 49
CO2 EC uS/cm	2, 36	2, 38	2, 65	2, 39
pH	7, 70	7, 70	7, 96	5, 89
Langelier Index	0, 37	0, 36	1, 39	-5, 51
StiffDavis Index	0, 40	0, 039	1, 17	-5, 49

4. Pretreatment

Measurement against CaCO3: None

Inhibit Incr. SO4 and CO3: None

Reject Saturation Index: 0, 0 max. ( )

5. Conversion Limit

For	Rejection	Saturation	Max. Conv.
CaSO4	9, 69E-5	32, 1%	77, 3%
BaSO4	8, 98E-10	0, 0%	95, 0%
SrSO4	9, 43E-10	0, 0%	95, 0%
CaF2	1, 06E-14	0, 0%	95, 0%
Si	-	0, 0%	95, 0%

6. Water treatment

Treat water measurement: None

- ***Dose calculation and dose adjustment***

Type of product: Flocculants

Density: 1, 3 kg/l

Feed plant flow	20m³/day 0, 83 m³/hour
Dose volume	25ppm

Maximum daily consumption: 0, 50 kg/d
Maximum daily schedule: 20, 83 g/h
Schedule flow: 16, 03 ml/h

Treat water concentration (% vol):	20%	
Mix flow schedule:	80, 13 ml/h	
Mix daily volume:	1, 92 l/d	
Schedule volume:	0, 08 l/h	
Tank volume:	50l	
Time between fill tank:	26, 0 days	50lt
Dose control		
Size Dose:	0, 75 l/h	10, 7%
Speed:	32, 7%	
Stroke:	32,7%	

7.2. Irrigation System

We have considered for the irrigation system, the following specifications to dimension the Irrigation Plant:

- ✓ Crop: Tomato.
- ✓ Number of plants: 1000.
- ✓ Flow x plant= 3 l/h;
- ✓ Irrigation time= 5 min x irrigation;
- ✓ Flow= 50 L/min=3000 l/h;
- ✓ Irrigation Volume= 250 l x irrigation;
- ✓ Drainage: 60 %;
- ✓ Drainage Volume= 150 l x irrigation;

According to this irrigation flow, we have selected pumps Lowara CEA 120/5 with a nominal flow of 3,6 m3/h and a discharge pressure of 2,82 bar (g) for the irrigation system.

To feed the fertilizers thank and the main nutritive solution tank from the Osmosis Plant and for the water that return from the drainage treated tank, we have choose the pump Lowara CEA 210/4 that provides more flow (8,4 m3/h).

For the fertilizer system we use magnetic pumps with a nominal flow of 0,48 m3/h. The injectors works between 0-500 l/h.

We have considered PVC with nominal diameter of 40 mm in all the circuits. The pressures losses considering nominal flow 3 m3/h and length of pipe 100 m, are very low.

In the following table are showed the results of the pressure losses calculation:

		1	2
1. Flow medium			
Flow medium		Water (1,013 bar, 20 °C)	
Condition		liquid	
Volume flow	m3/h	3,000	
Mass flow	kg/h	2994,618	
Volume flow branch.pipe	m3/h		
Density	kg/m3	998,206	
Dyn.Viscos.	10-6 kg/ms	1001,605	
Kin.Viskosität	10-6 m2/s	1,003	
2. Additional data for gases			
Pressure (inlet, abs.)	bar		
Temperature (inlet)	°C		
Temperature (outlet)	°C		
Norm volume flow	Nm3/h		
3. Element of pipe			
Pipe identification		Plastic pipe PVC DIN 8062	
Element of pipe		circular	
Number		1	
Dimensions of element	SI	Diameter of pipe D in mm: 46,400	
		Length of pipe L in m: 100,000	
4. Result of calculation			
Veloc.of flow	m/s	0,493	
Reynolds number		2,279E+04	
Veloc.of flow2	m/s		
Reynolds number 2			
Flow		turbulent	
Absolute roughness	mm	0,100	
Pipe friction number		0,029	
Resistance coefficient		63,490	
Resistance coefficient bran			
Press. drop branch.pipe	bar		
Pressure drop	bar	0,077	
Pressure drop	bar	0,077	
Sum Pressure drop	bar	0,077	

The instrumentation and the elements of the plant will have nominal diameter of 32 mm. The valves will have body in plastic and are electrically operated.

7.3. UV System

To disinfect the drainage water we are going to use a sterilizer by UV light with an electrical consumption of 30 W and a nominal flow of 19 L/m. The material of the lamp is stainless steel AISI 316. The equipment will have an hour counter and alarm for maintenance. The estimated live of the lamp is 9000 h.

8. Electrical Control Box and Signals

The process is controlled by two PLCs that send the signals to the main control box. Those signals are sends to two power boxes that operate all the pumps and electrical valves of the process. In the following table are showed all the digital outputs that come from both PLCs:

SYSTEM	TAG	SIGNAL	VOLTAGE	CONTROLLER
Osmosis	*P1*	*DO*	*12Vcc*	*PLC OSMOSIS*
Osmosis	*P2*	*DO*	*12Vcc*	*PLC CEBAS*
Osmosis	EV1	DO	12Vcc	PLC OSMOSIS
Osmosis	EV2	DO	12Vcc	PLC CEBAS
Osmosis	EV3	DO	12Vcc	PLC CEBAS
Osmosis	EV4	DO	12Vcc	PLC CEBAS
Osmosis	EV5	DO	12Vcc	PLC CEBAS
Osmosis	EV6	DO	12Vcc	PLC CEBAS
Osmosis	EV7	DO	12Vcc	PLC CEBAS
Osmosis	EV8	DO	12Vcc	PLC CEBAS
Osmosis	EV9	DO	12Vcc	PLC CEBAS
Osmosis	TK1	DO	12Vcc	PLC CEBAS
Irrigation	EVF1	DO	12Vcc	PLC CEBAS
Irrigation	EVF2	DO	12Vcc	PLC CEBAS
Irrigation	EVF3	DO	12Vcc	PLC CEBAS
Irrigation	EVF4	DO	12Vcc	PLC CEBAS
Irrigation	EVF5	DO	12Vcc	PLC CEBAS
Irrigation	EVF6	DO	12Vcc	PLC CEBAS
Irrigation	EVF6	DO	12Vcc	PLC CEBAS
DO	LS1	DO	12Vcc	PLC CEBAS
DO	LS2	DO	12Vcc	PLC CEBAS
DO	LS3	DO	12Vcc	PLC CEBAS
DO	LS4	DO	12Vcc	PLC CEBAS

DO	LS5	DO	12Vcc	PLC CEBAS
DO	LS6	DO	12Vcc	PLC CEBAS
Irrigation	P3	DO	12Vcc	PLC CEBAS
Irrigation	P4	DO	12Vcc	PLC CEBAS
Irrigation	P5	DO	12Vcc	PLC CEBAS
Irrigation	P6	DO	12Vcc	PLC CEBAS
Irrigation	P7	DO	12Vcc	PLC CEBAS
Irrigation	P8	DO	12Vcc	PLC CEBAS
Irrigation	P9	DO	12Vcc	PLC CEBAS
Irrigation	P10	DO	12Vcc	PLC CEBAS
Irrigation	P11	DO	12Vcc	PLC CEBAS
Irrigation	P12	DO	12Vcc	PLC CEBAS
Irrigation	M1	DO	12Vcc	PLC CEBAS
Irrigation	S1	DO	12Vcc	PLC CEBAS
Irrigation	EV10	DO	12Vcc	PLC CEBAS
Irrigation	EV11	DO	12Vcc	PLC CEBAS
Irrigation	EV12	DO	12Vcc	PLC CEBAS
Irrigation	EV13	DO	12Vcc	PLC CEBAS
Irrigation	EV14	DO	12Vcc	PLC CEBAS
Irrigation	EV15	DO	12Vcc	PLC CEBAS
Irrigation	EV16	DO	12Vcc	PLC CEBAS
Irrigation	TK2	DO	12Vcc	PLC CEBAS
Irrigation	LS7	DO	12Vcc	PLC CEBAS
Irrigation	LS8	DO	12Vcc	PLC CEBAS
Irrigation	LS9	DO	12Vcc	PLC CEBAS
Disinfection	P13	DO	12Vcc	PLC CEBAS
Disinfection	P14	DO	12Vcc	PLC CEBAS
Disinfection	EV18	DO	12Vcc	PLC CEBAS
Disinfection	EV19	DO	12Vcc	PLC CEBAS
Disinfection	EV20	DO	12Vcc	PLC CEBAS
Disinfection	TK3	DO	12Vcc	PLC CEBAS
Disinfection	TK4	DO	12Vcc	PLC CEBAS

9. Technical specifications

9.1. Pumps

SYSTEM	ID	SPECIFICATION	P (kW)/V	F(m3/h)	P(Bar (g))
Osmosis	P1	Lowara CEA 120/5	0,9/400	3,6	2,82
Osmosis	P2	Lowara CEA 210/4	1,5/400	8,4	2,45
Irrigation	P3	Proindecsa PD30R	0,045/230	0,480	0,33
Irrigation	P4	Proindecsa PD30R	0,045/230	0,480	0,33
Irrigation	P5	Proindecsa PD30R	0,045/230	0,480	0,33
Irrigation	P6	Proindecsa PD30R	0,045/230	0,480	0,33
Irrigation	P7	Proindecsa PD30R	0,045/230	0,480	0,33
Irrigation	P8	Proindecsa PD30R	0,045/230	0,480	0,33
Irrigation	P9	Proindecsa PD402	0,065/400	2,1	1,4
Irrigation	P10	Lowara CEA 120/5	0,9/400	3,6	2,82
Irrigation	P11	Lowara CEA 120/5	0,9/400	3,6	2,82
Irrigation	P12	Lowara CEA 120/5	0,9/400	3,6	2,82
Disinfection	P13	Lowara CEA 120/5	0,9/400	3,6	2,82
Disinfection	P14	Lowara CEA 210/4	1,5/400	8,4	2,45

9.2. Osmosis Plant

The operation parameters of the Osmosis Plant are indicated in the following table:

	Unit	Operation Range
Feed Temperature	ºC	18-23
Feed Redox	mV	‹400
Feed conductivity	µS/cm	‹2500
Treat water conductivity	µS/cm	‹50
Treat water flow	l/h	500
Recirculation Flow	l/h	390
Reject Flow	l/h	330
Sand Filter pressure entrance	BAR	3-4 bar
Carbon filter pressure entrance	BAR	3-4 bar
Cartridge filter pressure entrance	BAR	3-4 bar
High pressure pump pressure entrance	BAR	8-9 bar
High pressure pump pressure output	BAR	8-9 bar
Reject Pressure	BAR	8-9 bar

The main units that form the entire system of the plant are the following:

1. Osmosis Frame

2. Chemical Pretreatment
    2.1 Flocculants Dosage Unit
    2.2 Hypochlorite Dosage Unit
    2.3 Inhibitor Dosage Unit
3. Physical Pretreatment
    3.1 Filtration Phase active crystals
    3.2 Filtration Phase active Carbon
    3.3 Microfiltration Phase
4. Pumped Unit High Pressure
5. Reverse Osmosis Unit
6. Chemical cleaning of the membranes
7. Measurement and control instrument
8. Electrical Installation/Distribution panel
9. Pipes
10. Valves

1. **Osmosis Frame**

The design it has been considered a frame, in which mechanical equipment, measurement and control equipment installed, and electrical cabinet and pressure pipes reserve osmosis membranes. The frame will be built in beams and stainless steel.

2. Chemical Pretreatment

2.1 Flocculants Dosage Units

Dosing Pump	
Amount	1
Manufacturer	**DOSAPRO**
Type	Electromagnetic membrane
Dose	Manual: 5-100 gpm
Movement	Manual: 20% - 100%
Pump material	PVC
Membrane material	Teflon
Max. Flow	0´75 l/h
Max. Backpressure	10´3 bar
Electrical power supply	220 V. 50Hz
Max. Consumption	7 W
Four Functions Valves	Retention, Anti-syphon, line depressurization, Pressure relief
Material	Polypropylene,
Capacity	50 l.

2.2 Hypochlorite Dosage Unit

Dosing Pump	
Amount	1
Manufacturer	**DOSAPRO**
Type	Electromagnetic membrane
Dose	Manual: 5-100 gpm
Movement	Manual: 20% - 100%
Pump material	PVC
Membrane material	Teflon
Max. Flow	0´75 l/h
Max. Backpressure	10´3 bar
Electrical power supply	220 V. 50Hz
Max. Consumption	7 W

Four Functions Valves	Retention, Anti-syphon, line depressurization, Pressure relief
Material	Polypropylene,
Capacity	50 l.

2.3 Inhibitor Dosage Unit

Dosing Pump	
Amount	1
Manufacturer	**DOSAPRO**
Type	Electromagnetic membrane
Dose	Manual: 5-100 gpm
Movement	Manual: 20% - 100%
Pump material	PVC
Membrane material	Teflon
Max. Flow	0´75 l/h
Max. Backpressure	10´3 bar
Electrical power supply	220 V. 50Hz
Max. Consumption	7 W
Four Functions Valves	Retention, Anti-syphon, line depressurization, Pressure relief
Material	Polypropylene,
Capacity	50 l.

3. Physical Pretreatment

3.1 Filtration Phase Active Crystals

Pressure filters	
Units	1
Valves	
Manufacturer	OSMONICS
Type	263
Operation Flow	0´83 m³/h
Programmer	Logix 742 F, chronometric
Connection	1¨ male
Bottle	
Type	Vertical
Max. Work pressure	8 bar
Body material	Polyester reinforced with fiberglass
Cristal Load active	120 kg
Shutoff valve during regeneration	

3.2 Filtration Phase active Carbon

Pressure filters	
Units	1
Valves	
Manufacturer	OSMONICS
Type	263
Operation Flow	0´83 m³/h
Programmer	Logix 742 F, chronometric
Connection	1¨ male
Bottle	
Type	Vertical
Max. Work pressure	8 bar
Body material	Polyester reinforced with fiberglass

Cristal Load active	70 kg
Shutoff valve during regeneration	

3.3 Microfiltration Phase

Case for cartridge filters	
Units	1
Unitary Capacity	1´22 m³/ h
Filter	
Nº of cartridges per unit	1
Cartridge length	20¨
Design pressure	6 bar
Filtration Speed	0,061m³/h. inch
Body material	PVC
Cartridge material	Polypropylene

4. Pumped Unit High Pressure

Units	1
Manufacturer	GRUNDFOS
Type	Vertical Multiphase Centrifugal
Design flow	1´22 m³/h
Design pressure	13 bar
Materials	Stainless steel AISI 316
Speed	2.900 rpm
Electric Motor	
Motor potential	1´5 kW
Electrical power supply	3 x 400 V. 50 Hz

5. Reverse Osmosis Unit

Pressure pipes	
Units	4
Manufacturer	BEL or PENTAIR
Type	Frontal entrance
Diameter	4´´
Material	PRFV
Approximate Length	1´3 m.
Nominal pressure	21 bar
Osmosis Membrane	
Units	4
Manufacturer	Toray or Hydranautics
Approximate Length	1m
Diameter	4´´
Material	Aromatic polyamide winding low pressure spring

6. Chemical cleaning of the membranes

Moto Pump Group	
Unit	1
Type	Multiphase Centrifugal
Design flow	2m³/h
Driven pressure	4 bar
Material	AISI 604
Motor Potential	0´75 kW
Electrical power supply	1 x 230 V. 50 Hz
Chemical cleaning deposit	1

Material	High density Polypropylene
Capacity	125 l. graduated scale
Flushing deposit	1
Material	High density Polypropylene
Capacity	250 l. graduated scale
Level Switch	
Units	1

7. Measurement and control instrument

The installation has a measurement and control equipment necessary to know at any given time the plant´s performance and to ensure automatic stops. The offer included the following equipments:

Level Switches

The dose units and deposit that require and are include in our supply units.

Flow meters

Manufacturer	FIP or TECFLIUD
Type	Variable area
Pipe material	Trogamid
Material	Stainless Steel

- Treat water 1 unit
- Reject 1 unit
- Chemical Cleaning 1 unit
- Re-circulated 1 unit

Manometer

Manufacturer	WIKA	
Model	213.53.63	
Material	Stainless box	
Liquid	Glycerin	
Diameter	63	
Sand Filtration Unit at the entrance		1 unit
Microfiltration at the entrance		1 unit
High Pressure Pump at the entrance		1 unit
Membrane entrance in the pipe		1 unit
Reverse osmosis rejection in the pipe		1 unit

Pressure Switch

Manufacturer	DANFOSS
Model	KP 35
Range	0.2-7.5 bar
High pressure pump´s suction	1 unit

Pressure Transmitters

Manufacturer	WIKA
Material	Stainless
Range	

- 0-10 bar 2 units
- 0.25 bar 2 units

Sand Filtration Unit at the entrance	1 unit
High Pressure Pump at the entrance	1 unit
Membrane entrance in the pipe	1 unit

Reverse osmosis rejection in the pipe 1 unit

Conductivity meter

Manufacturer	SEKO
Transmitters	Kontrol 40
Units	2
Communications	Exit signal 0/4.20Ma
Set point	2 separate relays
Electrical power supply	100…230V AC (50/60Hz)
Sensor	2 units
Body	PP
Electrodes	AISI 316

- Treat water (range 2-10.000 *µs)* *1 unit*
- *Feed (range 0-200 µs)* *1 unit*

8. Electrical Installation/Distribution panel

The plant has an electrical control system that manage the different operating modes, alarms, emergency and necessary processes.
The electrical cabinet is built in painted stainless. Contain all necessary components for the electrical control of the plant, will be completed with cables and protected under community legislation. The electrical design is the following, has a general protection and particular for each element. The electrical and control panel

- Phase power supply switch 400V 502Hz
- Magnetothermic protection and consumer differential
- Pushbutton to start in automatic mode
- Pushbutton to stop automatic mode
- Screen that display the treat water conductivity

The electrical control is managed by a programmable automaton, which sends the order to accomplish action on each process or situation. The automaton includes programming display, alarm indication, information.

9. Pipes

High pressure will use pipe PVC-HTA PN25 for the conductions in which the working pressure is higher than 10 bar.

Low pressure will use pipe PVC 16 for the conductions in which the working pressure is lower than 10 bar.

10. Valves

High pressure will use stainless steel valves AISI 316L or equivalent in conductions in which the working pressure is higher than 10 bar.

Low pressure will use valves PVC 16 for the conductions in which the working pressure is equal to 10 bar.

9.3. Flow Meters

SYSTEM	ID	SPECIFICATION	Lxpulse	D
Osmosis	F1	Arad Group 600100050	1	3/4”
Osmosis	F2	Arad Group 600100050	1	3/4”
Osmosis	F3	Arad Group 600100200	1	3/4”
Osmosis	F4	Arad Group 600100050	1	3/4”
Irrigation	F5	Arad Group 600100050	1	3/4”
Irrigation	F6	Arad Group 600100050	1	3/4”
Irrigation	F7	Arad Group 600100050	1	3/4”
Irrigation	F8	Arad Group 600100050	1	3/4”
Irrigation	F9	Arad Group 600100050	1	3/4”
Irrigation	F10	Arad Group 600100050	1	3/4”
Irrigation	F11	Arad Group 600100050	1	3/4”
Disinfection	F12	Arad Group 600100200	1	3/4”
Disinfection	F13	Arad Group 600100200	1	3/4”
Disinfection	F14	Arad Group 600100200	1	3/4”
Disinfection	F15	Arad Group 600100200	1	3/4”
Disinfection	F16	Arad Group 600100200	1	3/4”
Disinfection	F17	Arad Group 600100200	1	3/4”

9.4. Electrical Valves

SYSTEM	ID	SPECIFICATION	Vac	D
Osmosis	EV1	Bermad 200 Series	24	1”
Osmosis	EV2	Bermad 200 Series	24	1”
Osmosis	EV3	Bermad 200 Series	24	1”
Irrigation	EVF1	FIP S12	24	8 mm
Irrigation	EVF2	FIP S12	24	8 mm
Irrigation	EVF3	FIP S12	24	8 mm
Irrigation	EVF4	FIP S12	24	8 mm
Irrigation	EVF5	FIP S12	24	8 mm
Irrigation	EVF6	FIP S12	24	8 mm

Osmosis	EV4	Bermad 200 Series	24	1”
Osmosis	EV5	Bermad 200 Series	24	1”
Osmosis	EV6	Bermad 200 Series	24	1”
Osmosis	EV7	Bermad 200 Series	24	1”
Osmosis	EV8	Bermad 200 Series	24	1”
Osmosis	EV9	Bermad 200 Series	24	1”
Irrigation	EV10	Bermad 200 Series	24	1”
Irrigation	EV11	Bermad 200 Series	24	1”
Irrigation	EV12	Bermad 200 Series	24	1”
Irrigation	EV13	Bermad 200 Series	24	1”
Irrigation	EV14	Bermad 200 Series	24	1”
Irrigation	EV15	Bermad 200 Series	24	1”
Irrigation	EV16	Bermad 200 Series	24	1”
Disinfection	EV17	Bermad 200 Series	24	1”
Disinfection	EV18	Bermad 200 Series	24	1”
Disinfection	EV19	Bermad 200 Series	24	1”
Disinfection	EV20	Bermad 200 Series	24	1”
Disinfection	EV21	Bermad 200 Series	24	1”

9.5. Instrumentation

SYSTEM	ID	SPECIFICATION	V
Osmosis	PT1	Pressure Transducer	12 Vcc
Osmosis	PS1	Pressure Switch	24 Vca
Osmosis	PS2	Pressure Switch	24 Vca
Osmosis	TK1	Control Level Omron	24 Vca
Irrigation	TK2	Control Level Omron	24 Vca
Disinfection	TK3	Control Level Omron	24 Vca
Disinfection	TK4	Control Level Omron	24 Vca
Osmosis	LS1	Level Sensor	24 Vca
Osmosis	LS2	Level Sensor	24 Vca
Osmosis	LS3	Level Sensor	24 Vca
Osmosis	LS4	Level Sensor	24 Vca

Osmosis	LS5	Level Sensor	24 Vca
Osmosis	LS6	Level Sensor	24 Vca
Irrigation	LS7	Level Sensor	24 Vca
Irrigation	LS8	Level Sensor	24 Vca
Irrigation	LS9	Level Sensor	24 Vca
Irrigation/Drainage	pH	pH Sensor Sensovant	12 Vcc
Irrigation/Drainage	CE	CE Sensor B&C Electronics	12 Vcc
Pluviometer	PV	Pluviometer Davis Instrument	24 Vca

10. Conclusions

In the design phase, we have tried to simplify the installation. As most of the pumps have the same requirements, we have considered only two different models for the process (Lowara 120/5 and 210/4). For the fertilizers we have used magnetic pumps with special requirements to support the corrosion (Proindecsa PD30R/PD402).

As the flow is low, we have considered, excepting for the fertilizers tanks where we use 25 mm, pipes with nominal diameter of 40 mm for all the pipes. All the pipes are made in PVC.

The control valves are made in plastic, have a nominal diameter of 1” and they will be electrically operated.

The design of the Osmosis Plant has been made without a chemical analysis, thinking about an EC range between 1000-2.500 µs. For that reason, the pressure, flow and quality of the water will be variable.

To increase the efficiency of the UV Systems, we have included a filter to eliminate the main particles that comes from the Raw Drainage Tank.

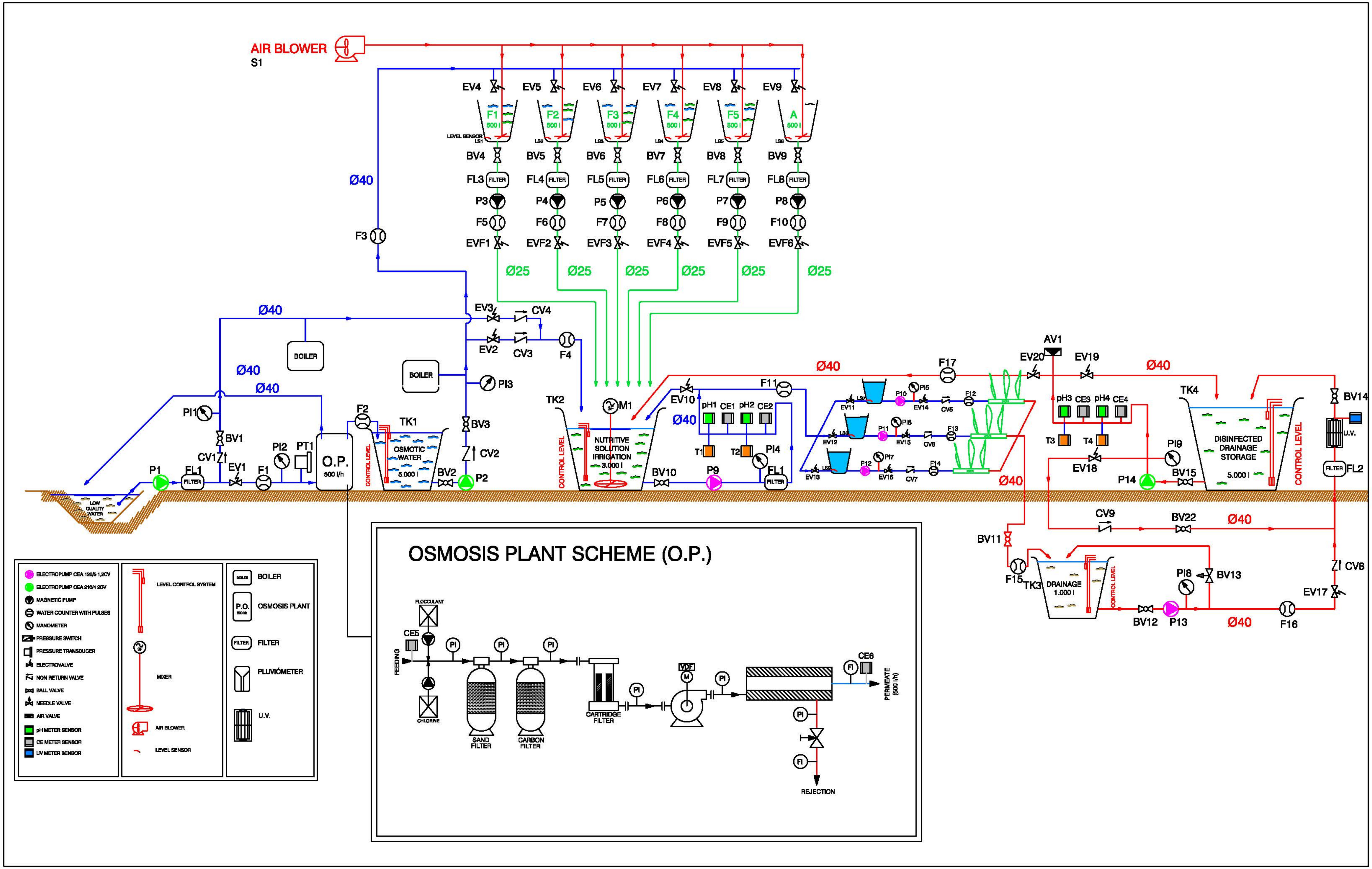
The whole plant is automatically controlled. To achieve this goal; we have made several changes in the initial design. At the beginning, the signals coming from the sensors came directly to the linking electrical board, and it sent those signals to the PLCs. For simplicity, the signal sensors will go directly to the PLCs and they will process this information.

At this time, we are beginning the installation phase and possibly we will have to make more changes in the design until the facility is finished.

When the installation is operative, we can take conclusions about water saving and the others goals described in this document.

11. P&ID

The following drawing is showed the Pipes and Instrumentation Diagram, where the whole process is described:



AIR BLOWER
S1
EV4
EV5
EV6
EV7
EV8
EV9
F1
F2
F3
F4
F5
A
500 l
LEVEL SENSOR
BV4
BV5
BV6
BV7
BV8
BV9
FL3
FL4
FL5
FL6
FL7
FL8
FILTER
P3
P4
P5
P6
P7
P8
F5
F6
F7
F8
F9
F10
EVF1
EVF2
EVF3
EVF4
EVF5
EVF6
Ø25
Ø40
F3
EV3
CV4
EV2
CV3
F4
BOILER
PI3
BV3
CV2
P2
BV2
TK1
OSMOTIC WATER
5.000 l
CONTROL LEVEL
F2
O.P.
500 l/h
PI2
PT1
F1
EV1
CV1
BV1
PI1
P1
FL1
LOW QUALITY WATER
TK2
M1
NUTRITIVE SOLUTION IRRIGATION
3.000 l
BV10
P9
EV10
pH1
CE1
pH2
CE2
T1
T2
PI4
FL1
F11
F17
EV11
EV12
EV13
EV14
EV15
EV16
CV6
CV7
F12
F13
F14
PI5
PI6
PI7
P10
P11
P12
AV1
EV20
EV19
pH3
CE3
pH4
CE4
T3
T4
EV18
PI9
P14
BV15
TK4
DISINFECTED DRAINAGE STORAGE
5.000 l
CONTROL LEVEL
BV14
U.V.
FL2
CV9
BV22
BV11
F15
TK3
DRAINAGE
1.000 l
PI8
BV13
BV12
P13
F16
CV8
EV17
OSMOSIS PLANT SCHEME (O.P.)
FLOCCULANT
CE5
FEEDING
CHLORINE
PI
SAND FILTER
CARBON FILTER
CARTRIDGE FILTER
VDF
M
FI
CE6
PERMEATE (500 l/h)
REJECTION
ELECTROPUMP CEA 120/5 1,2CV
ELECTROPUMP CEA 210/4 2CV
MAGNETIC PUMP
WATER COUNTER WITH PULSES
MANOMETER
PRESSURE SWITCH
PRESSURE TRANSDUCER
ELECTROVALVE
NON RETURN VALVE
BALL VALVE
NEEDLE VALVE
AIR VALVE
pH METER SENSOR
CE METER SENSOR
UV METER SENSOR
LEVEL CONTROL SYSTEM
MIXER
AIR BLOWER
LEVEL SENSOR
BOILER
OSMOSIS PLANT
P.O.
FILTER
PLUVIÓMETER
U.V.