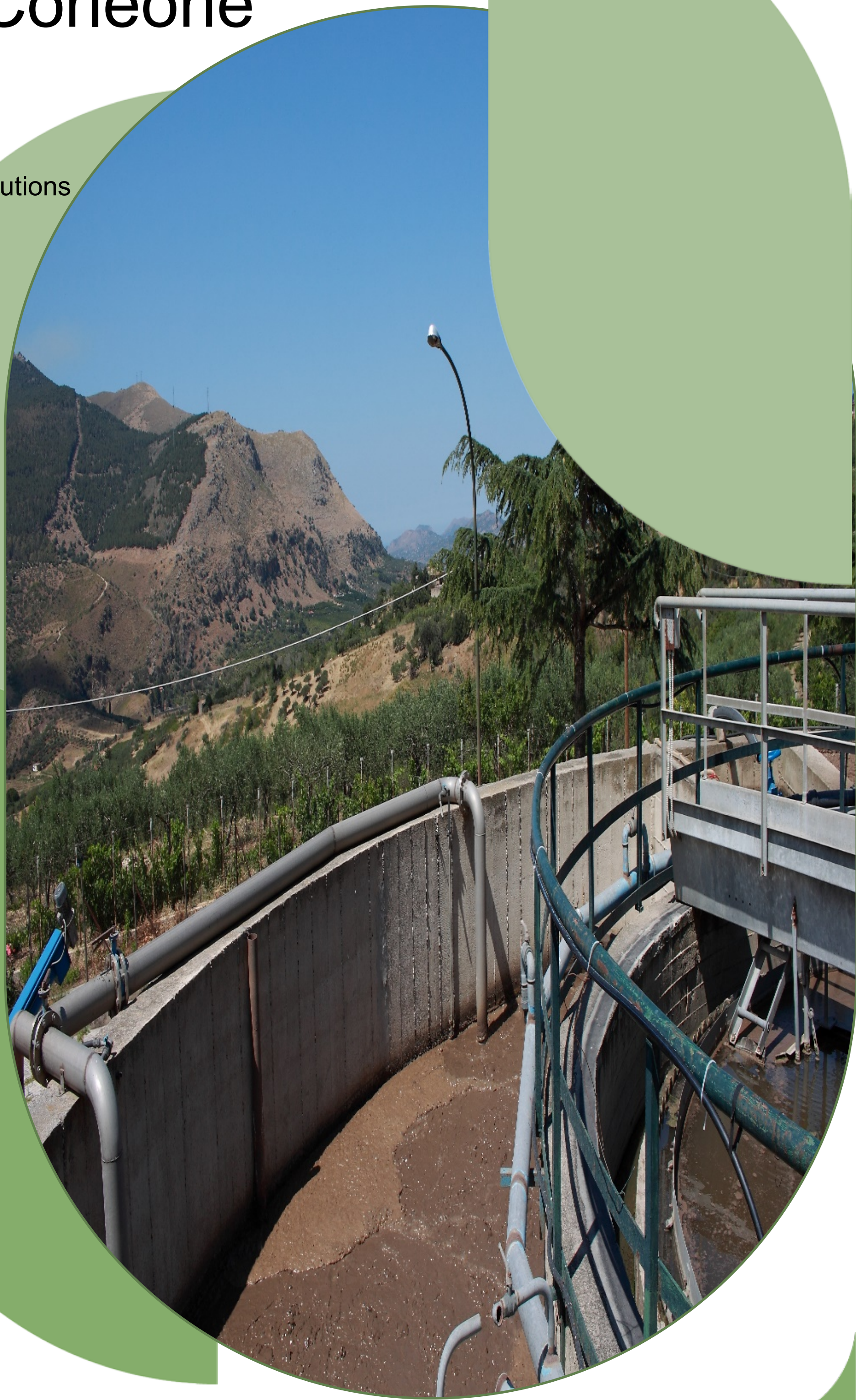
DELIVERABLE NUMBER D1.1

# Demonstration plant for testing and development at Marineo and Corleone

*UNIPA, Giorgio Mannina*

*April-2021*

Achieving wider uptake of water-smart solutions
Project number: 869283
Project duration: May 2020 – April 2024
H2020-SC5-2019-2
WWW.WIDER-UPTAKE.EU



**Disclaimer:** This deliverable has not yet been approved by the European Commision and should be seen as a draft.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

**D1.1 – Public**

# Demonstration plant for testing and development at Marineo and Corleone

| VERSION | DATE |
|---|---|
| 02 | 30-April-2021 |


## ABSTRACT

Deliverable D1.1 "Demonstration plant for testing and development at Marineo and Corleone was developed by UNIPA within Task 1.1 – "Reuse of wastewater for irrigation and production of slow-release fertilizers in agricultural industry, Sicily, Italy", led by UNIPA and AMAP, from WP1 - Demonstrations of water-smart solutions. This Deliverable aims at demonstrating the technical plant for pilot scale nutrient adsorption and testing to optimise resource recovery testing and development at Marineo and Corleone, completed and ready for use. From Task 1.1.2 to be used in Task 1.1.2 and Task 1.1.3.


| DELIVERABLE ID | WORK PACKAGE | PLANNED DELIVERY DATE |
|---|---|---|
| D1.1 | WP1 | 30-April-2021 |

## AUTHORSHIP AND APPROVAL INFORMATION


| LEAD BENEFICIARY | AUTHOR(S) |
|---|---|
| UNIPA | Giorgio Mannina (UNIPA)<br>Daniele Di Trapani (UNIPA)<br>Alida Cosenza (UNIPA) |

**REVIEWED BY**
Reviewer 1: Prof. Vito Armando Laudicina (UNIPA)
Reviewer 2: Prof. Stein Østerhus (NTNU)


## RELEASE HISTORY

| VERSION | DATE | VERSION DESCRIPTION/MILESTONE* DESCRIPTION |
|---|---|---|
| 01 | 15-March-2021 | Version released for PMT comments |
| 02 | 30 April 2021 | Revised and finalised version |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

## TABLE OF CONTENTS

1 INTRODUCTION .......... 3

2 CORLEONE WWTP .......... 4

2.1 Flow rate measuring devices .......... 4

2.2 UF membrane treatment system for water reuse .......... 5

2.3 New aeration system for biological reactors: working plan .......... 6

2.4 New WWTP configuration to minimize sewage sludge production and GHG emissions: working plan .......... 11

2.5 Replacement of sludge recirculation pumps .......... 12

3 MARINEO WWTP .......... 14

3.1 Shed for deviation line at Marineo .......... 14

3.2 Deviation line for PHA recovery .......... 14

3.3 Filters for nutrient recovery .......... 15

4 UNIPA WATER REUSE STATION .......... 17

5 CONCLUSIONS .......... 20

## LIST OF ANNEXES

**Annex 1** Design of a shed for deviation line (for PHA production/recovery) and filters (zeolite and biochar, for nutrient recovery) at Marineo WWTP

**Annex 2** Technical drawings of deviation line, filters for nutrient recovery and pilot plants (subcontracting)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

# 1 Introduction

In WIDER UPTAKE, demonstration activities are covered by WP1. These activities ensure the application of water smart solutions in batch/pilot and real scale.

Within WP1 UNIPA is the lead beneficiary of T1.1 “Reuse of wastewater for irrigation and production of slow-release fertilizers in agricultural industry, Sicily, Italy”. In particular, the activities will be focused on the demonstration at Marineo and Corleone wastewater treatment plants (WWTPs).
In particular, the following tasks have to be achieved:

T1.1.1: Developing of test methods and preparation of demonstration plants
T1.1.2: Pilot scale nutrient adsorption and testing to optimise resource recovery
T1.1.3: Demonstration of materials recovery and reuse of wastewater
T1.1.4: Results analysis and preparation of input to the roadmap

Specifically, Marineo WWTP will be devoted to nutrients and Polyhydroxyalkanoates (PHA) recovery. While, Corleone WWTP will be devoted to water reuse, minimization of sludge production and sewage sludge reuse.

This document summarizes the preparation activities carried out by UNIPA (from month 1 to month 12) focused on Deliverable D1.1 and aims at providing “Demonstration plant for testing and development at Marineo and Corleone”. The technical plant for pilot scale nutrient adsorption and testing to optimise resource recovery testing and development at Marineo and Corleone, completed and ready for use. From Task 1.1.2 to be used in Task 1.1.2 and Task 1.1.3.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author’s view.
The Commission is not responsible for any use that may be made of the information it contains.

# 2 Corleone WWTP

Corleone WWTP was designed for 12,000 inhabitant equivalents. Corleone WWTP has a typical conventional activated (CAS) process having two aerobic biological reactors with surface aeration followed by three final clarifiers. The WWTP also has membrane modules for final effluent filtration and a distribution network for water reuse (irrigation) by local agriculture and green urban areas (i.e., green gardens). Corleone WWTP will be devoted to water reuse in agriculture where an experimental field trial will be conducted for assessment of the field interactions among water-soil-plants.

## 2.1 Flow rate measuring devices

Within the WIDER UPTAKE project, with the aim to upgrade the WWTP monitoring equipment in the light of improving the plant performances, new flow meters were placed at Corleone WWTP with the aim to effectively measure the influent and effluent wastewater flow. In Figure 1, a view of the channel before and after the installation of flow meter is shown. The latter has been installed after the degritting channels, in order to monitor the influent flow rate to the WWTP.


*Figure 1: Before (a) and after (b) flow meter installation at the plant inlet*

In Figure 2, a panoramic view of the flow meter installed close to the disinfection unit, close to the WWTP outlet, is shown.

*Figure 2: Flow meter installation at the plant outlet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

## 2.2 UF membrane treatment system for water reuse

Before the Wider Uptake project, the WWTP of Corleone was characterized by several issues, among which the water reuse line which was out of operation. After the start-up of the Wider Uptake Project, the reuse line concerning in particular the membrane ultrafiltration (UF) modules were subjected to extraordinary maintenance activities, in order to restore the system operation. By the end of September 2020, the maintenance of the UF modules was almost completed. AMAP is waiting for a further technical check, in order to fix some minor issue with membrane backwashing.

Figures 3-5 show some details of the old pressure regulator, not working, (Figure 3-4) which was replaced with a new one.

*Figure 3: Pressure regulator of the UF modules before maintenance*

*Figure 4: Disassembly of the pressure regulator*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

*Figure 5: New pressure regulator of the UF modules*

It is worth noting that the UF membrane module is almost ready for the implementation of water reuse. Water will be temporarily stored and then transported to the users before completing the supply pipeline. The UF membrane treatment system provides 150 m$^3$/h of treated wastewater to be reused. The plant is ready to be used and will be started according to the project time schedule.

*Figure 6: View of the ultrafiltration membrane treatment system*

## 2.3 New aeration system for biological reactors: working plan

The existing aeration system (Figure 7) for the aerobic biological reactors (surface aerator) will be replaced with an aeration system by blowers (air compressed in blowers is transmitted via pipes to diffusers; these are elements that introduce the air to the mixed liquor, usually located near the bottom of a biological reactor). The adoption of aeration system by blowers allows to apply SMART control solutions (e.g., by means of a proportional–integral–derivative, PID) for reducing the plant energy demand.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.


*Figure 7: Existing surface aerator at Corleone WWTP*

The traditional approach for aeration system by blowers designing has been adopted. For the sake of conciseness, only the results will be summarized.

The amount of oxygen required by the biomass ($\Delta O_2$) [$kgO_2\ h^{-1}$] has been calculated according to Equation 1.

$$\Delta O_2 = a' \cdot (S_o - S_e) \cdot Q_{max,n} + b' \cdot V \cdot x \qquad (1)$$

Where: a' [-] is the active respiration coefficient, $S_o$ [$mg\ L^{-1}$] and $S_e$ [$mg\ L^{-1}$] are the influent and the effluent biodegradable oxygen demand (BOD) concentration, respectively; $Q_{max,n}$ [$m^{-3}\ h^{-1}$] is the maximum dry weather flows of influent wastewater; b' [$h^{-1}$] is the endogenous respiration coefficient; V [$m^3$] is the aerated reactor volume; x [$kgTSS\ m^{-3}$] is the biomass concentration in the aerated reactor.
In view of selecting the appropriate aeration system the standard oxygenation capacity at standard conditions ($O.C._{st}$) has been calculated according to Equation 2.

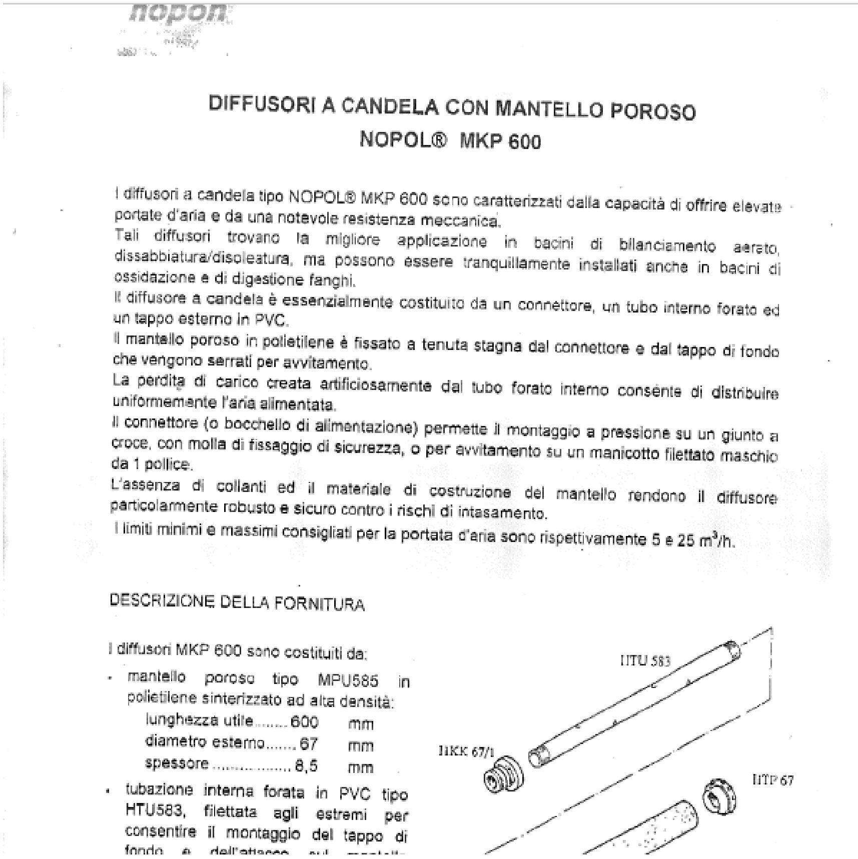
$$O.C._{st} = \frac{O.C.}{\alpha \cdot 1{,}024^{(T\max - 20)} \cdot \frac{\beta \cdot C_s * - C}{C*}} \qquad (2)$$

Where: O.C. [$kgO_2\ h^{-1}$] is the oxygenation capacity at actual conditions and is equal to $\Delta O_2$; α [–] is the oxygen transfer correction factor, dependant on the aeration system, and tank design; $T_{max}$ [°C] is the maximum reference temperature; ; β [–] is the salinity – surface tension correction factor; $C_s^*$ [$mgO_2\ L^{-1}$] is the saturation oxygen concentration in the aerobic reactor under the real conditions; C [$mgO_2\ L^{-1}$] is the desired oxygen concentration inside the aerobic reactor; $C_s$ [$mgO_2\ L^{-1}$] is the saturation oxygen concentration under standard conditions.

The amount of required air flow is 492 $m^3$/h, giving a required blower power of 8000 W. With regard to this, 72 fine-bubble diffusers (nominal pore, d < 3 mm bubbles) will be installed.

The features of the diffusers and the blower that will be installed are shown in Figure 8 and Figure 9, respectively.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.



nopon

DIFFUSORI A CANDELA CON MANTELLO POROSO
NOPOL® MKP 600

I diffusori a candela tipo NOPOL® MKP 600 sono caratterizzati dalla capacità di offrire elevate portate d'aria e da una notevole resistenza meccanica.
Tali diffusori trovano la migliore applicazione in bacini di bilanciamento aerato, dissabbiatura/disoleatura, ma possono essere tranquillamente installati anche in bacini di ossidazione e di digestione fanghi.
Il diffusore a candela è essenzialmente costituito da un connettore, un tubo interno forato ed un tappo esterno in PVC.
Il mantello poroso in polietilene è fissato a tenuta stagna dal connettore e dal tappo di fondo che vengono serrati per avvitamento.
La perdita di carico creata artificiosamente dal tubo forato interno consente di distribuire uniformemente l'aria alimentata.
Il connettore (o bocchello di alimentazione) permette il montaggio a pressione su un giunto a croce, con molla di fissaggio di sicurezza, o per avvitamento su un manicotto filettato maschio da 1 pollice.
L'assenza di collanti ed il materiale di costruzione del mantello rendono il diffusore particolarmente robusto e sicuro contro i rischi di intasamento.
I limiti minimi e massimi consigliati per la portata d'aria sono rispettivamente 5 e 25 $m^3/h$.

DESCRIZIONE DELLA FORNITURA

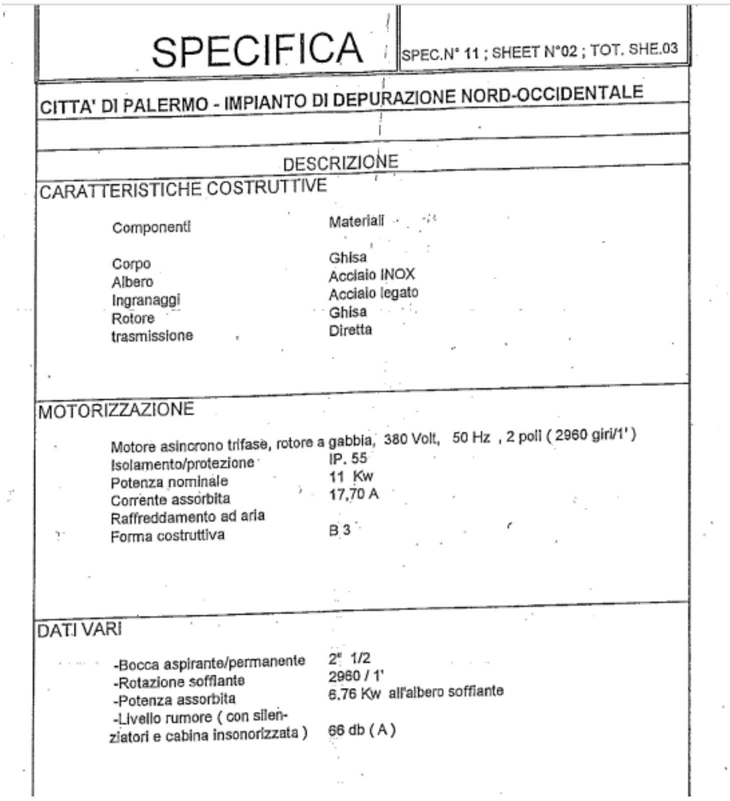
I diffusori MKP 600 sono costituiti da:

- mantello poroso tipo MPU585 in polietilene sinterizzato ad alta densità:
  - lunghezza utile........600 mm
  - diametro esterno.......67 mm
  - spessore.................8,5 mm
- tubazione interna forata in PVC tipo HTU583, filettata agli estremi per consentire il montaggio del tappo di fondo e dell'attacco ...



*Figure 8: Diffusers features*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.



SPECIFICA | SPEC.N° 11 ; SHEET N°02 ; TOT. SHE.03

CITTA' DI PALERMO - IMPIANTO DI DEPURAZIONE NORD-OCCIDENTALE

DESCRIZIONE

CARATTERISTICHE COSTRUTTIVE

| Componenti | Materiali |
| --- | --- |
| Corpo | Ghisa |
| Albero | Acciaio INOX |
| Ingranaggi | Acciaio legato |
| Rotore | Ghisa |
| trasmissione | Diretta |

MOTORIZZAZIONE

Motore asincrono trifase, rotore a gabbia, 380 Volt, 50 Hz , 2 poli ( 2960 giri/1' )

| | |
| --- | --- |
| Isolamento/protezione | IP. 55 |
| Potenza nominale | 11 Kw |
| Corrente assorbita | 17,70 A |
| Raffreddamento ad aria | |
| Forma costruttiva | B 3 |

DATI VARI

| | |
| --- | --- |
| -Bocca aspirante/permanente | 2" 1/2 |
| -Rotazione soffiante | 2960 / 1' |
| -Potenza assorbita | 6.76 Kw all'albero soffiante |
| -Livello rumore ( con silen-ziatori e cabina insonorizzata ) | 66 db ( A ) |

*Figure 9: Blower features*

Figure 10 shows the blower of the new aeration system.

*Figure 10: View of the blower of the new aeration system*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

The draft plan has been further developed to a working plan. Figure 11 shows the technical drawings of the executive plan. The replacement of the aeration system has been completed.

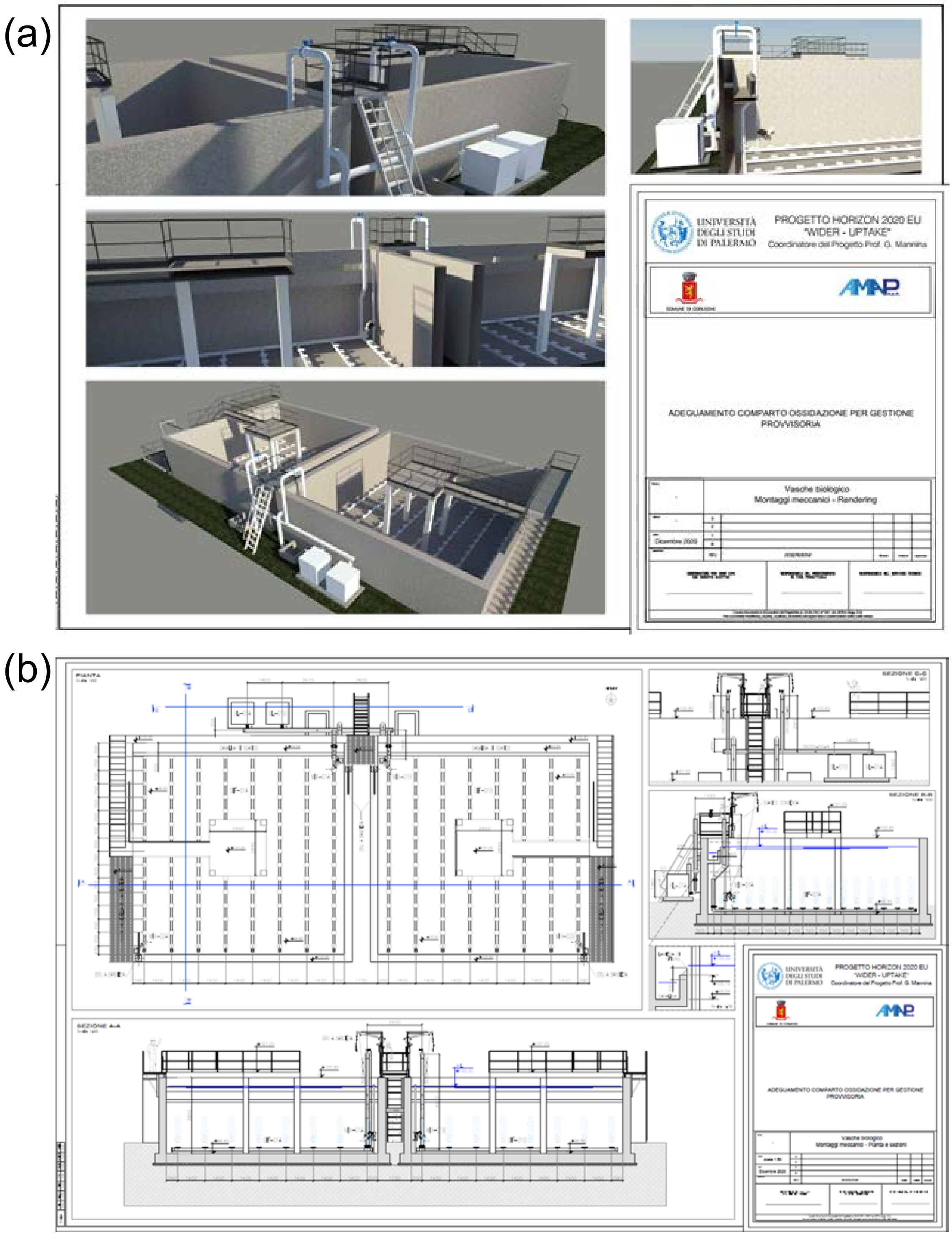



*Figure 11. (a) Rendering of the aeration system replacement and (b) executive drawings*

## 2.4 New WWTP configuration to minimize sewage sludge production and GHG emissions: working plan

Among the activities to be carried out within the Wider Uptake project, in order to improve the performance of the full scale WWTP, there was the minimization of excess sludge as well as GHG emission. Concerning the minimization of excess sludge production, the Corleone WWTP upgrading with an anaerobic sludge reactor, according to the oxic-settling-anaerobic (OSA) configuration, was carried out. Indeed, in one of the two aerobic reactor two mixers were installed in order to operate the tank under anaerobic conditions and guarantee efficient mixing. Several operational schemes will be implemented, with different complexity levels:

1. Both aerated tanks will be operated under aerobic conditions
2. One of the two aerobic reactors will be operated as OSA (anaerobic conditions) and the other one will be operated under aerobic conditions
3. One of the two aerobic reactors will be operated as OSA (anaerobic conditions) and the other one will be operated under intermittent aerobic conditions
4. Instrumentation Control Automation to optimize the process behaviour reducing the GHG emissions will be implemented.

For scheme 2 and 3 a pre-design has been performed. The anaerobic reactor pre-design was carried out by considering the hydraulic retention time (HRT) and the rate of RAS flow to be fed. It is worth noting that at present, Corleone WWTP has two empty tanks: one activated sludge reactor (available volume: 387 $m^3$) and one sludge digester (available volume: 164 $m^3$). Based on the available volume, it was found that the most suitable solution would be the use of one empty activated sludge reactor; in this latter case, the HRT and rate of RAS would be well in line with literature values for OSA systems. Figure 12 depicts the schematic layout of scheme 2), and Figure 13 summarizes the schematic layout of scheme 3).

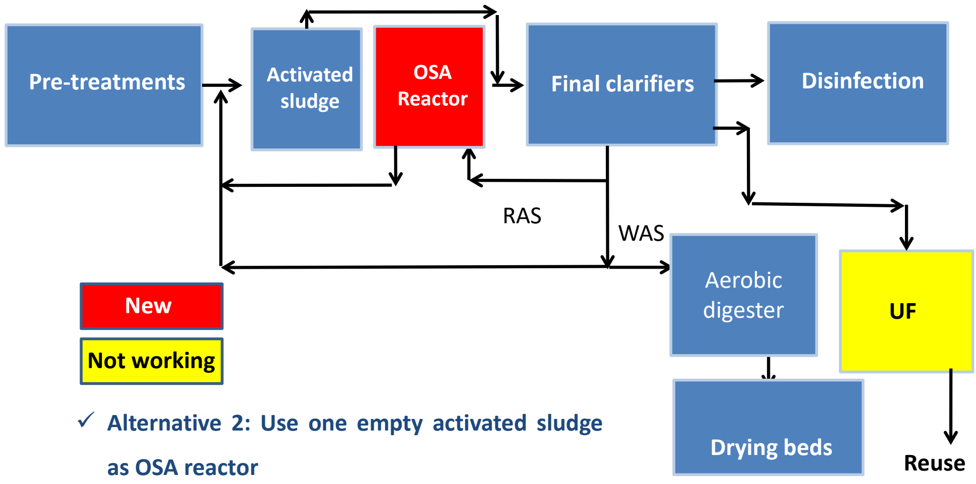



*Figure 12: Schematic layout of Scheme 1*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

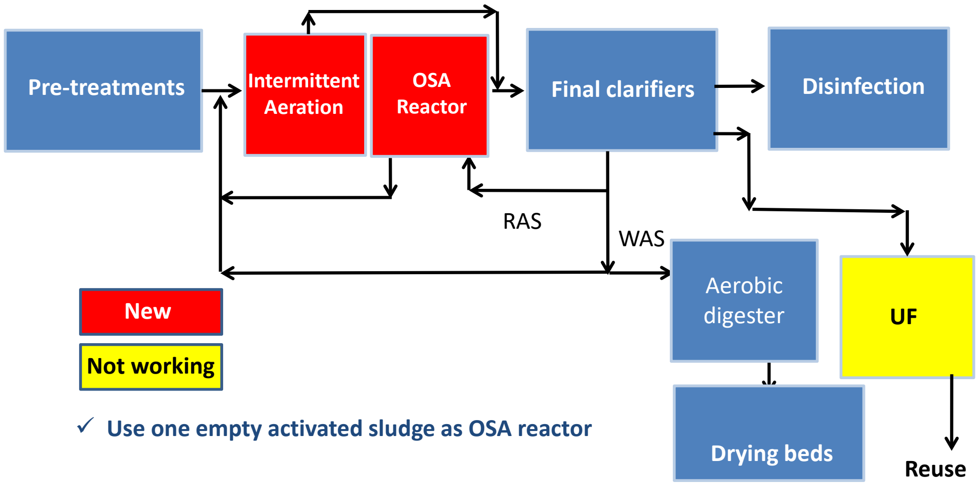



*Figure 13: Schematic layout of Scheme 2*

Figure 13 summarizes the Gantt chart of the activities related to the WWTP new configuration for sludge reduction.

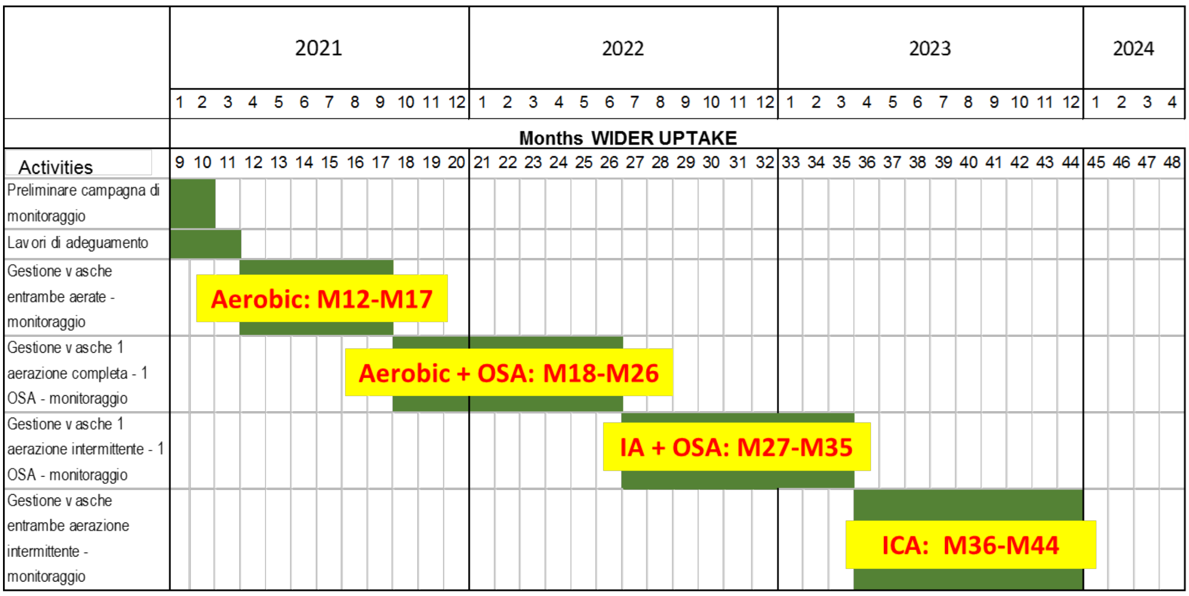



*Figure 13: Gantt chart of activities to be carried out at Corleone WWTP for sludge reduction*

## 2.5 Replacement of sludge recirculation pumps

The conventional activated sludge system layout considers the recirculation of the settled sludge from the bottom of the settler to the aerated activated sludge reactors. This operation is mandatory in view of maintaining high biomass concentration inside the aerated activated sludge reactors and consequently high pollutants removal efficiency. The existing recirculation pumps (Figure 14a) have been replaced with new pumps (Figure 14b) able to be automatically controlled. In this way, an effective plant optimization in terms of processes efficiency and energy consumption can be implemented.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

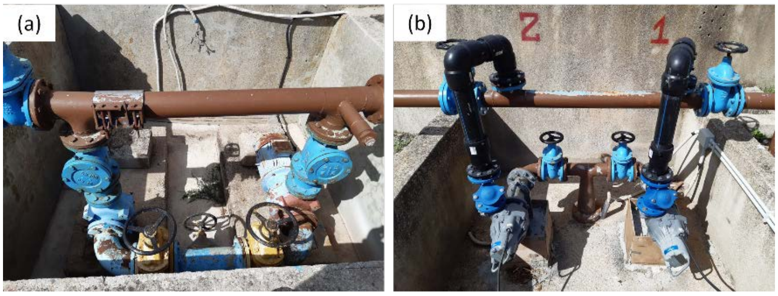



*Figure 14: Old recirculation pumps (a); new recirculation pumps (b)*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

# 3 Marineo WWTP

The Marineo WWTP was designed for 7,000 inhabitant equivalents. It has a CAS layout (with combined basins) followed by a surface filtration unit and UV disinfection. An irrigation network has been scheduled but not yet realized so at present the WWTP effluent is discharged in a nearby river. The Marineo WWTP will be devoted to material recovery, by implementing a process line for the PHA production /extraction as well as the installation of final filters filled with Biochar and zeolites for nutrients adsorption.

## 3.1 Shed for deviation line at Marineo

The construction of a covered location for the deviation line (for PHA production) has been completed; Figure 15 shows the shed for PHA production as well as the pipeline realization.

*Figure 15: Covered location for the deviation line and pipeline realization*

## 3.2 Deviation line for PHA recovery

The construction of the deviation line for PHA production at Marineo WWTP has been completed. The deviation line for PHA production and extraction, is comprised by a fermenter unit for volatile fatty acid (VFA) production, a sequencing batch reactor for the growth of PHA accumulating organism (namely, SBR1) and a sequencing batch reactor for accumulation of PHA (namely, SBR 2).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

The main parameters taken into account for the design were the influent flow rate to be treated, the HRT of the fermenter unit, the HRT of SBR 1 and SBR 2, based on literature and previous experiences. In Figure 16, a schematic layout of Marineo deviation line for PHA production is shown.

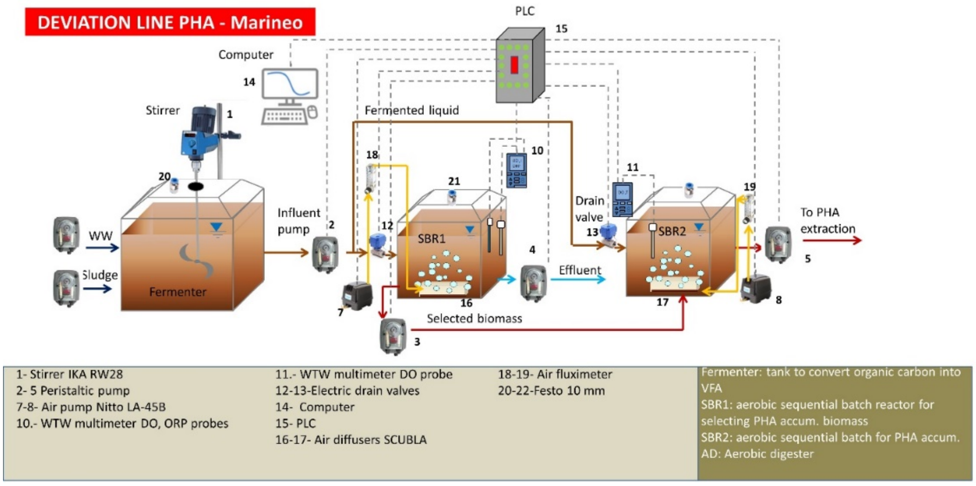



*Figure 16: Schematic layout of Marineo deviation line for PHA production*

In Figure 17 a panoramic view as well as the installed poster of the deviation line for PHA production ready to be used is shown.


*Figure 17: Panoramic view and poster of Marineo deviation line for PHA production*

## 3.3 Filters for nutrient recovery

One of the main activities to be carried out at Marineo WWTP will be the nutrients (nitrogen and phosphorus) recovering from the effluent flow. Two adsorption columns have been realized and filled with adsorbent material (biochar and zeolites) with the aim to recover nutrients from the effluent streams. The filter columns have been installed next to the outlet section of Marineo WWTP. The design of the filter columns was carried out by using empty bed contact time (EBCT) and flow velocity based on data from the literature. The geometrical features of the columns are:

- Height: 0.6 m
- Diameter: 0.1 m
- Volume: 4.71 L
- Surface area: 0.008 $m^2$

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

In Figure 18, a schematic layout of the filter columns at Marineo WWTP is shown.

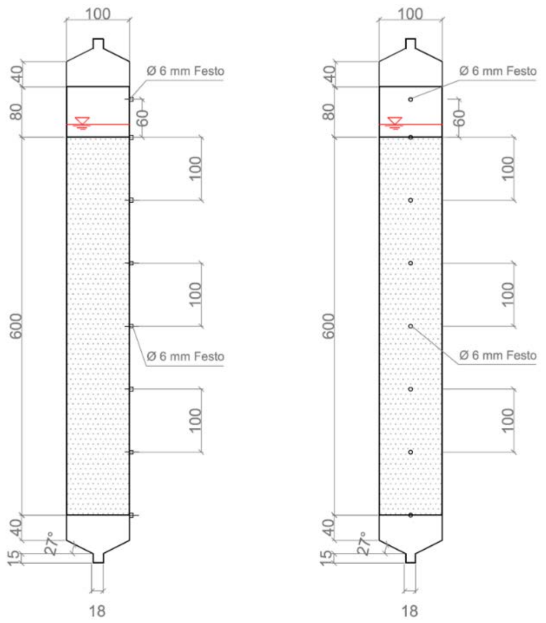



*Figure 17: Schematic layout of columns at Marineo WWTP for nutrient adsorption*

The filtration unit has been installed inside the shed for deviation line and in Figure 18 a view of the adsorption columns is shown.

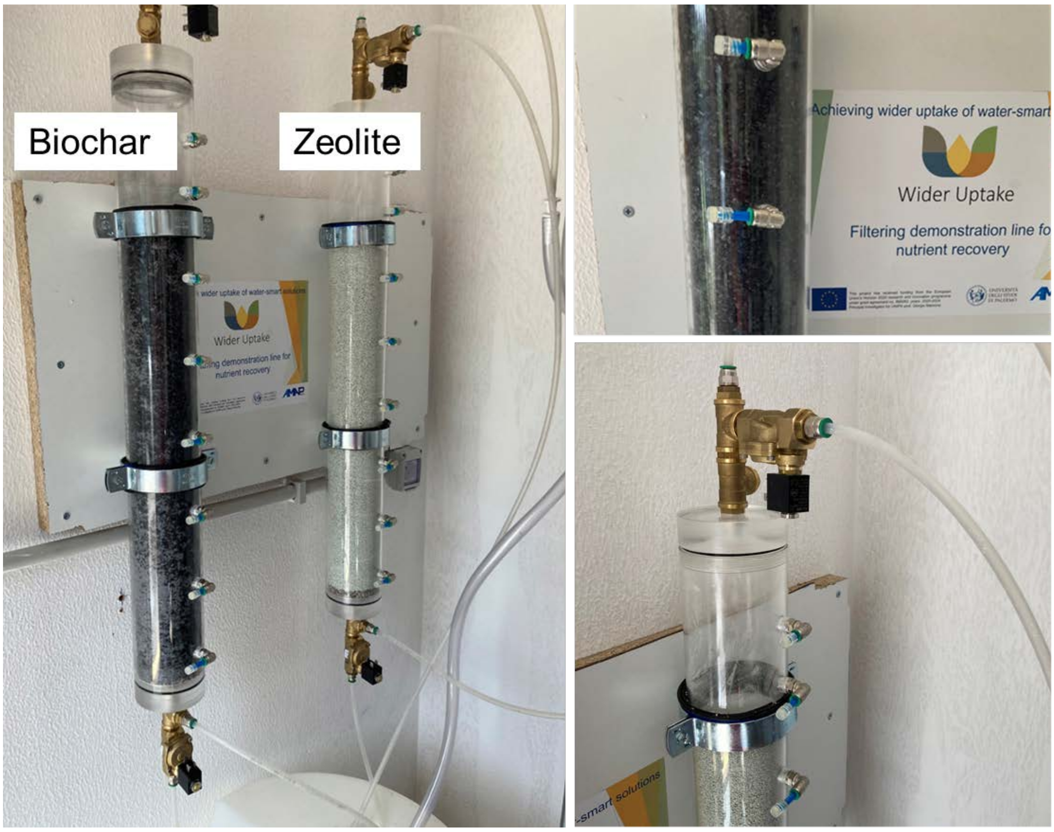



*Figure 18: Panoramic view and details of adsorption columns installed at Marineo WWTP for nutrient* recovery

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

# 4 UNIPA water reuse station

In order to accomplish the lab/pilot scale activity within the Wider Uptake project, there will be the need to derive a portion of wastewater flow rate from the main sewer of the University Campus. In this light, the design of this pump station has been done and the Board of Directors of Palermo University has approved it. The activities have been carried out in cooperation with AMAP s.p.a. Company, including the design calculations concerning the pipeline, the pumps, and the excavation. In Figure 19 a panoramic view of the pipeline route for wastewater pumping as well as treated water and irrigation is shown, whilst Figure 20 shows a panoramic view of the water reuse station highlighting its main components.

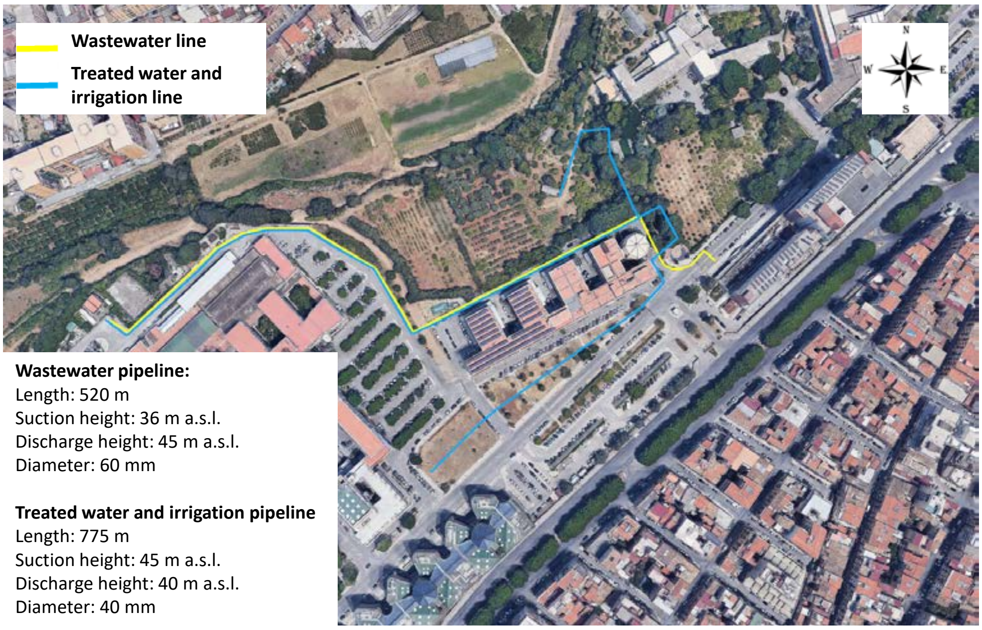



*Figure 19: Panoramic view of the pipeline route for wastewater and treated water pumping at Palermo* University Campus

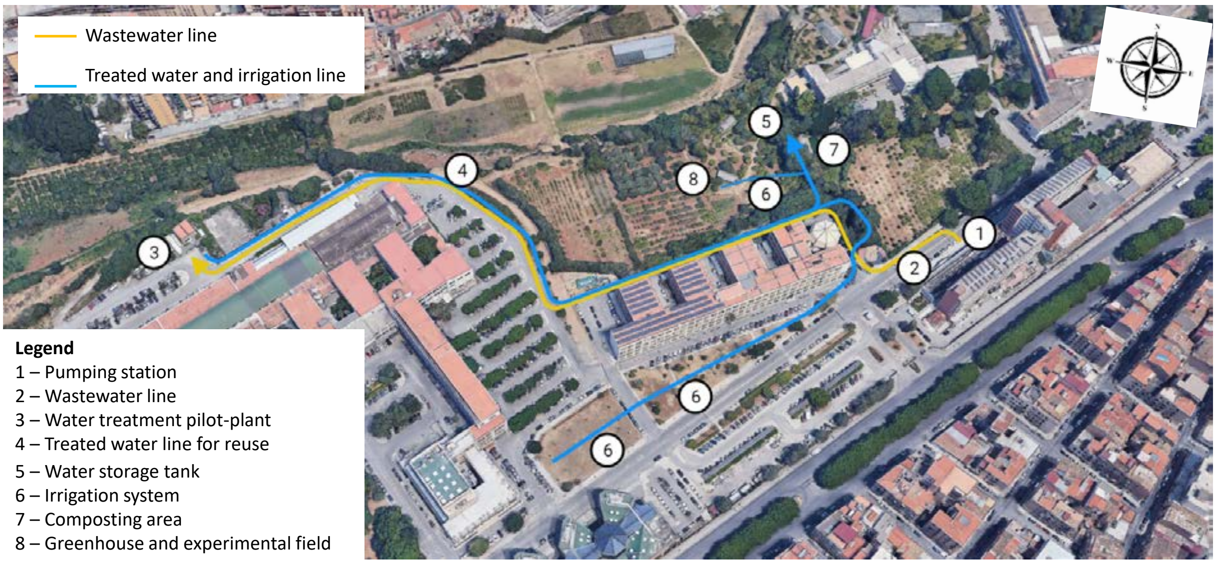



*Figure 20: Panoramic view of Unipa Campus with the main elements of the reuse station*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

The pumps are contained in a PRFV tank (Figure 21), and the pipeline is made of high-density polyethylene (HDPE). Figure 22 shows some images of the HDPE pipeline and fiberglass polyester tank during installation.


*Figure 21: Installed Fiberglass polyester tank (a) and pumping station (b) of the real wastewater*

*Figure 22: HDPE pipeline and fiberglass polyester tank during installation*

In Figure 23, a panoramic view of stainless-steel storage tanks (a), irrigation pipeline (b), irrigation area (c), greenhouse (d) and composting area (e) is shown.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.


*Figure 23: Panoramic view of stainless-steel storage tanks (a), irrigation pipeline (b), irrigation area (c), greenhouse (d) and composting area (e)*

The following Figure 24 shows a panoramic view as well as some details of the pilot plant for wastewater treatment and reuse.


*Figure 24: Panoramic view and details of the pilot plant for wastewater treatment*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

# 5 Conclusions

This document summarizes all the activities carried out according to delivery D1.1 “Demonstration plant for testing and development at Marineo and Corleone” by UNIPA showing the deviation line ready to be used.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author’s view.
The Commission is not responsible for any use that may be made of the information it contains.

# ANNEXES

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

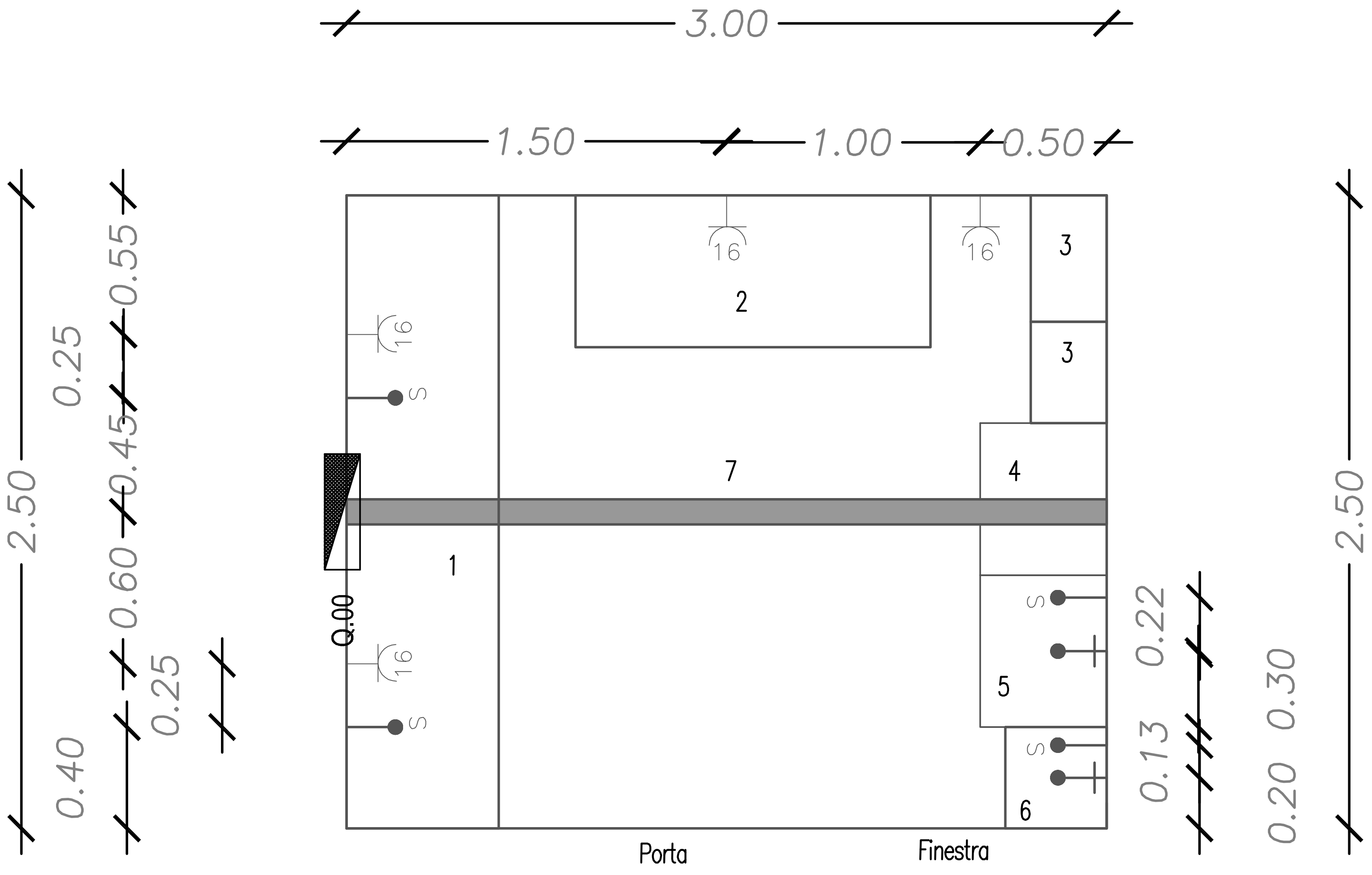
***Annex 1***

*Design of a shed for deviation line (for PHA production/recovery) and filters (zeolite and biochar, for nutrient recovery) at Marineo WWTP*

**D.1.1**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

# Particolari struttura pre-fabbricata Marineo




Legenda

Q.00 Quadro elettrico

16 Presa elettrica 220 V

S Scarico acqua

Punto acqua

1 Piano impianti pilota
2 Scrivania
3 Armadietto
4 Gocciolatoio
5 Lavatoio
6 Buttatoio
7 Canaletta di drenaggio

Scala 1:25
Foglio A4

***Annex 2***

*Technical draw of deviation line, filters for nutrient recovery and pilot plants (subcontracting)*

D.1.1

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869283. This presentation reflects only the author's view.
The Commission is not responsible for any use that may be made of the information it contains.

UNIVERSITÀ DEGLI STUDI DI PALERMO

DIPARTIMENTO DI INGEGNERIA

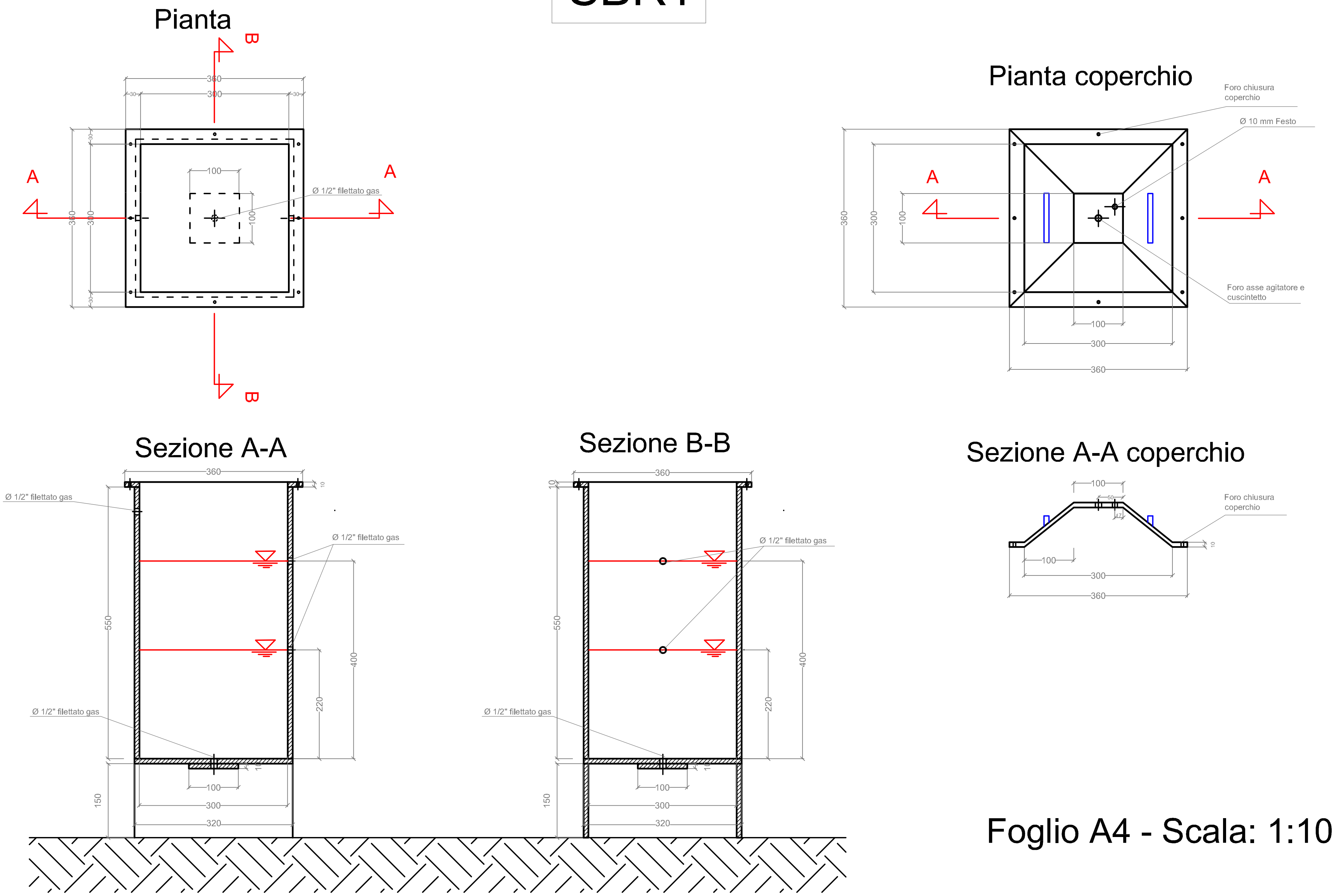
Direttore: Prof. Giovanni Perrone

# Elaborati grafici per la realizzazione di impianti pilota, da banco e linee dimostrative

Progetto: Achieving wider uptake of water-smart solutions – WIDER UPTAKE – Horizon 2020, GA n. 869283, Voce di costo del Bilancio Unico PRJ-0132, CUP B71C19000420006

viale delle Scienze – Edificio 8 - 90128 Palermo – C.F. 80023730825 – P.IVA. 00605880822
Amministrazione (+39) 091 238 65314/96769/96774/97210/97933 – Fax: ( +39) 091 427121

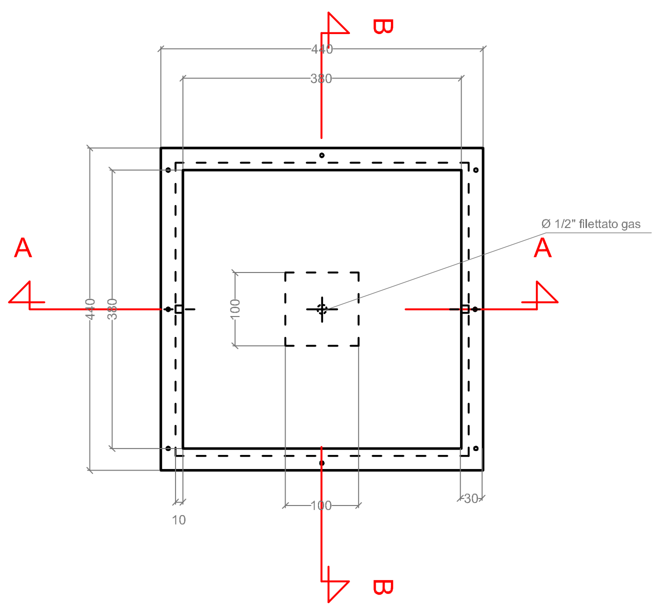
# SBR1



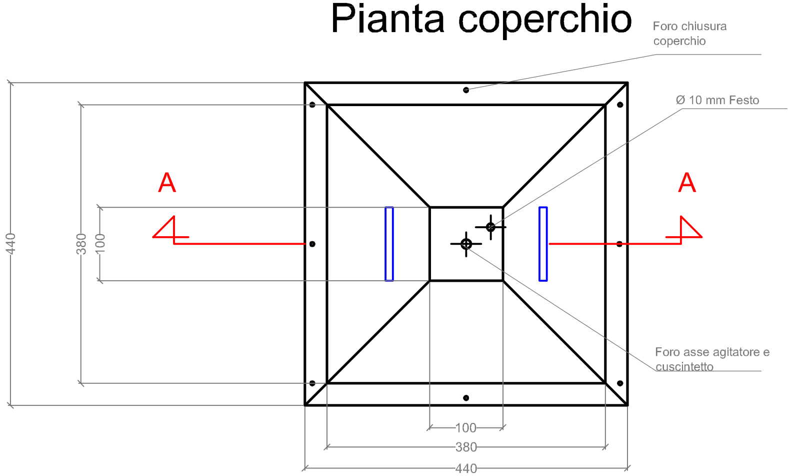

Foglio A4 - Scala: 1:10

# SBR2

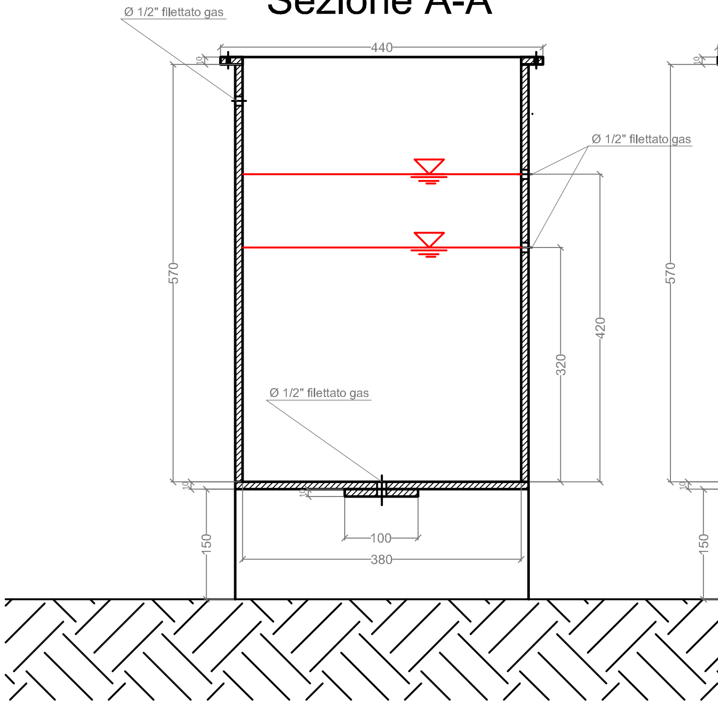
## Pianta



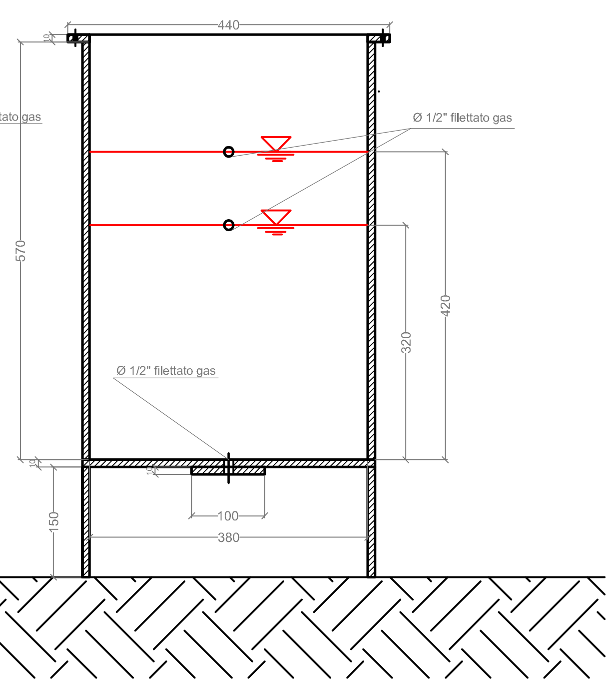

## Pianta coperchio



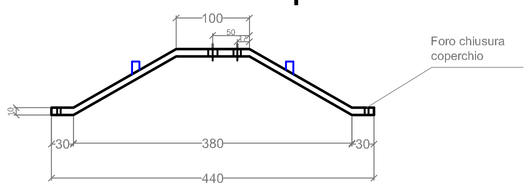

## Sezione A-A




## Sezione B-B

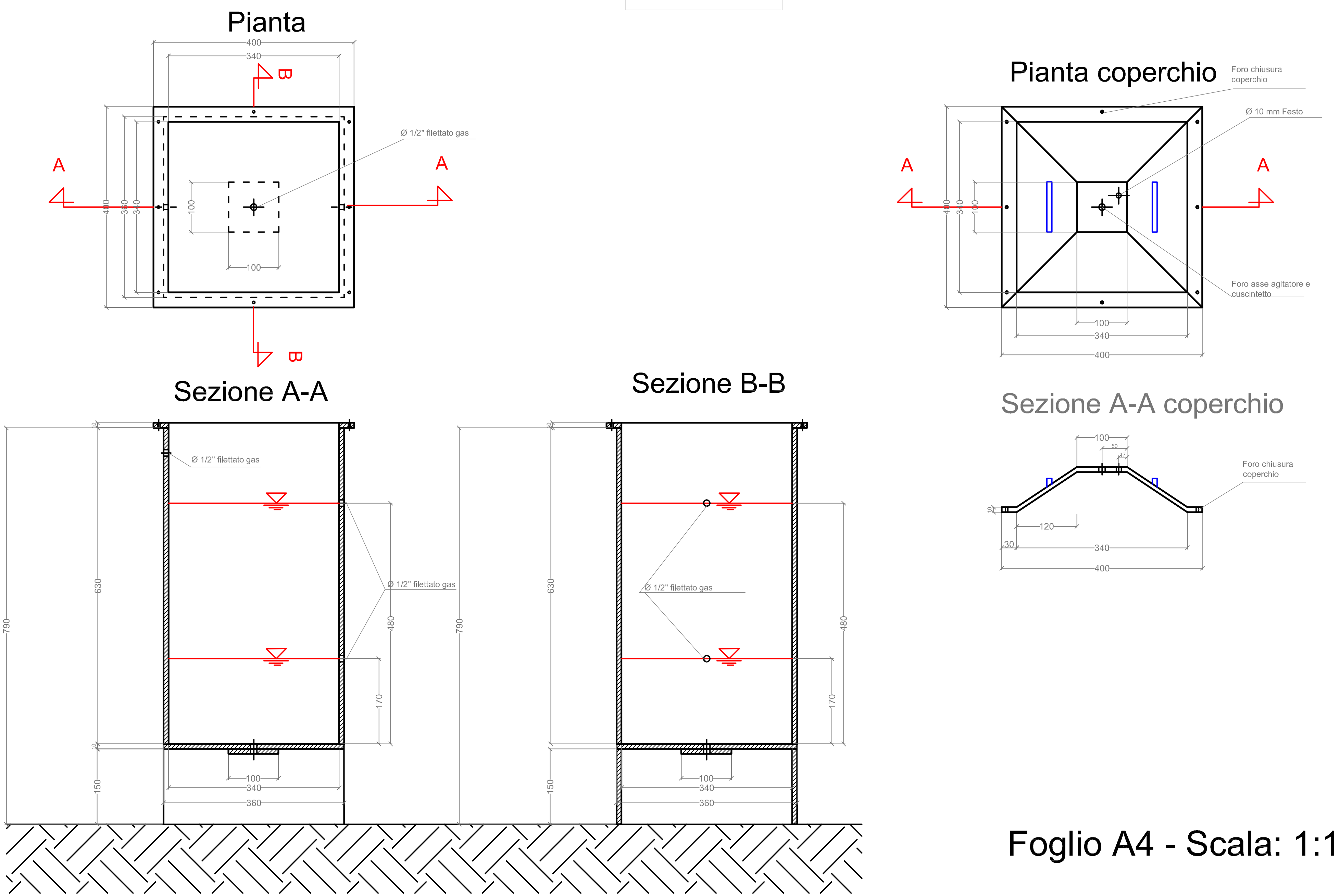



## Sezione A-A coperchio



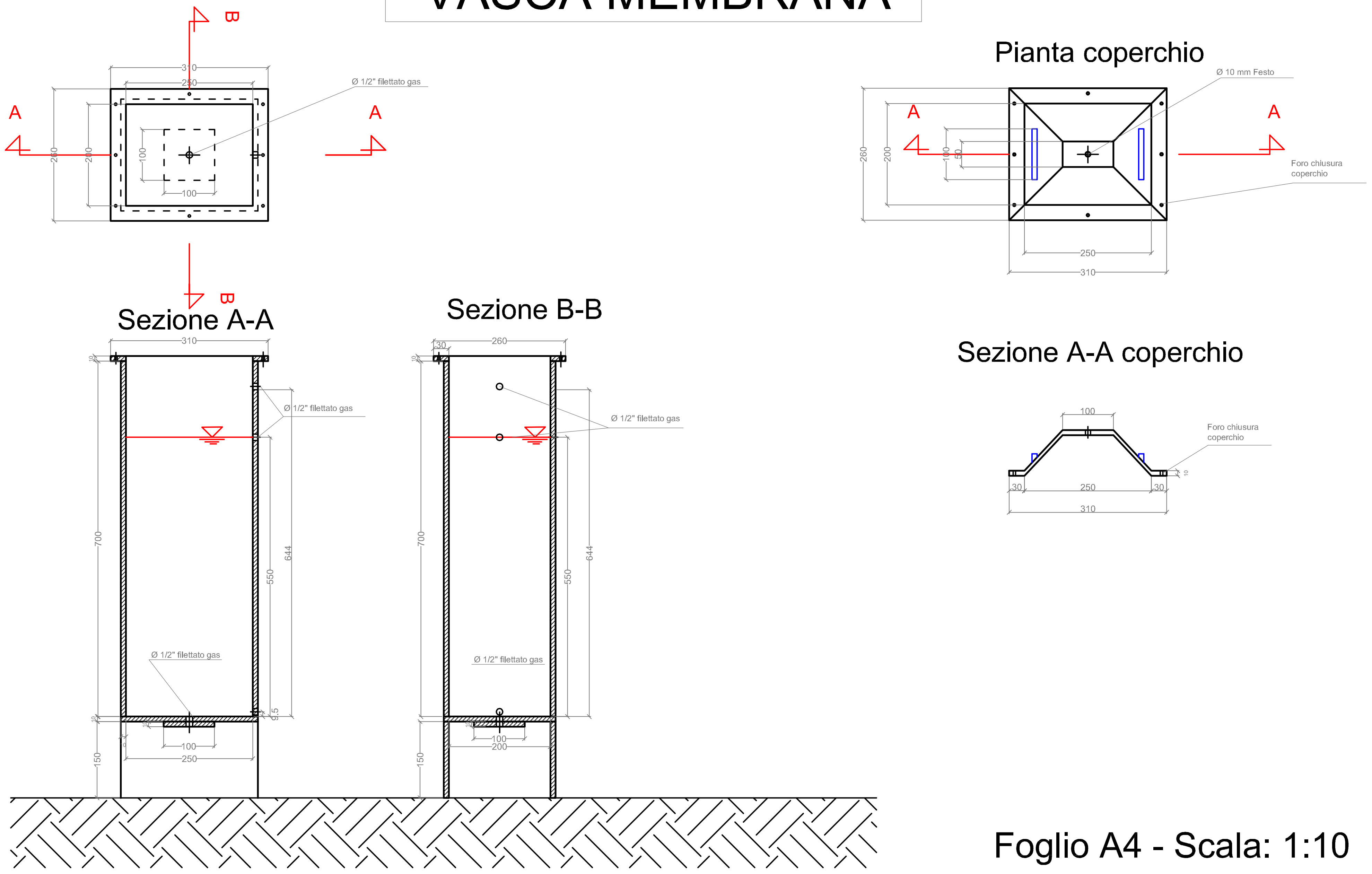

Foglio A4 - Scala: 1:10

# SBR3




Foglio A4 - Scala: 1:10

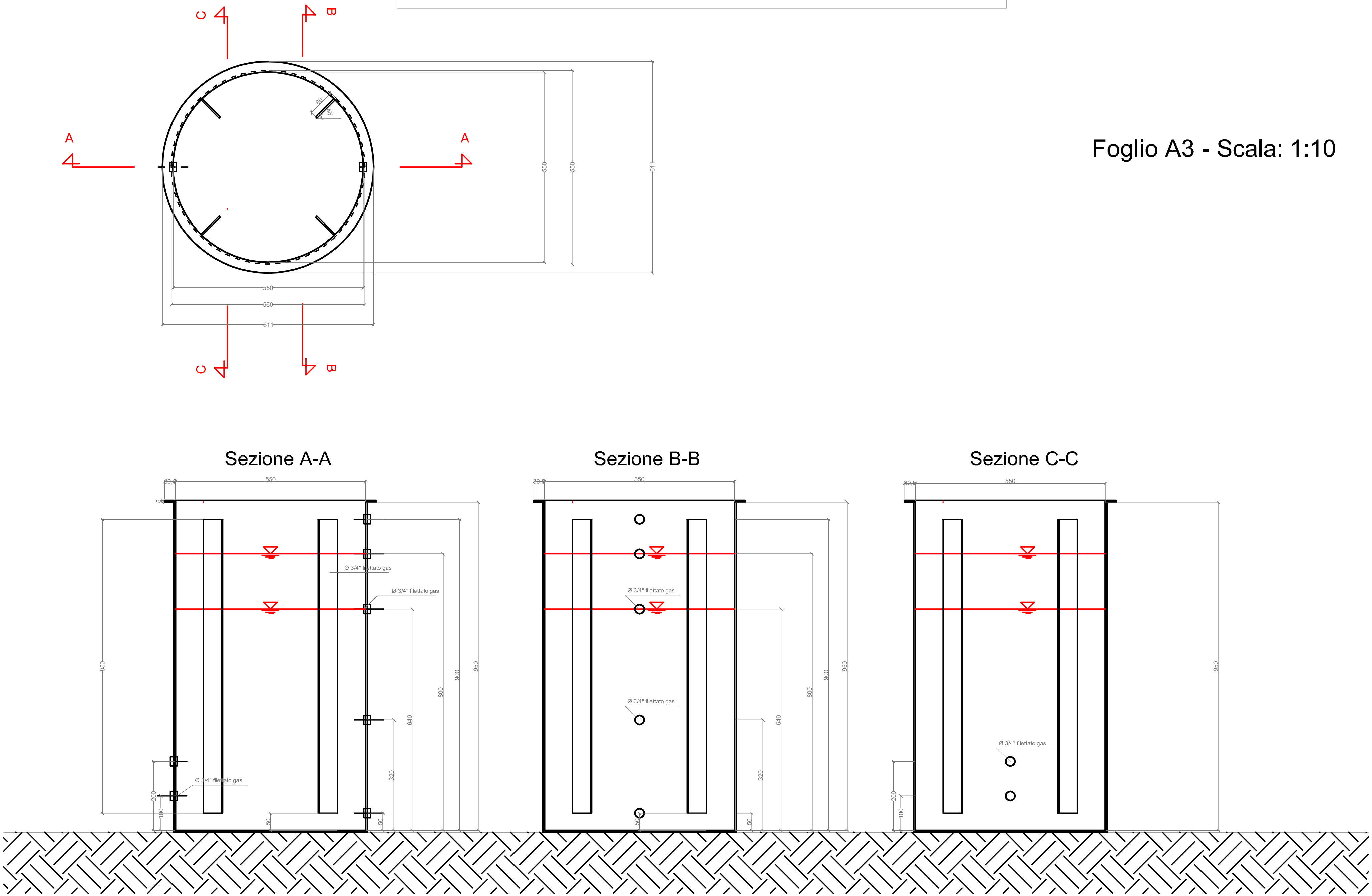
# VASCA MEMBRANA




Foglio A4 - Scala: 1:10

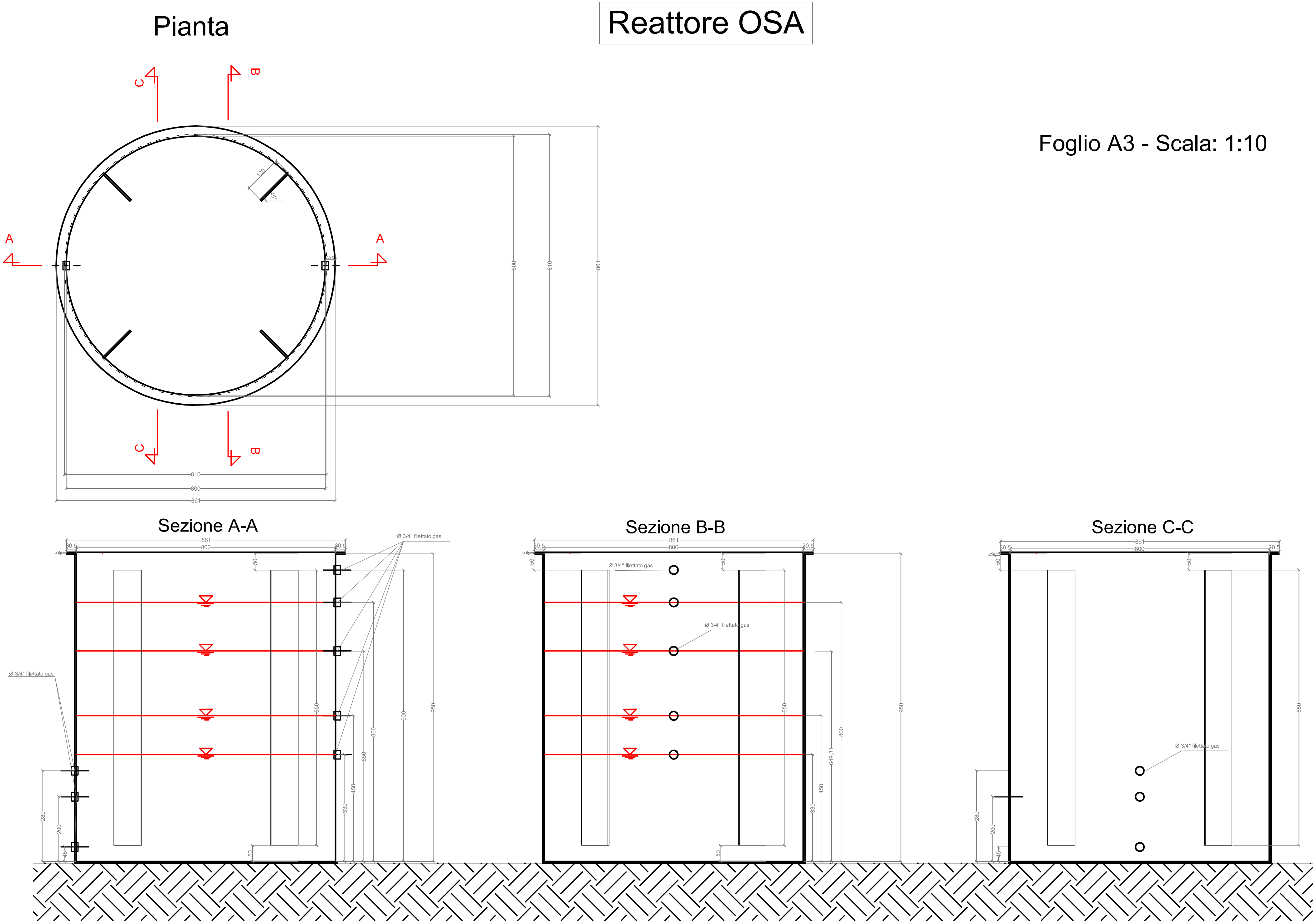
# Fermentatore a servizio impianto PHA

Foglio A3 - Scala: 1:10



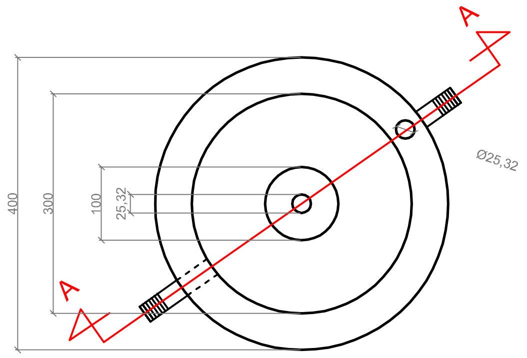
# Reattore OSA

Foglio A3 - Scala: 1:10

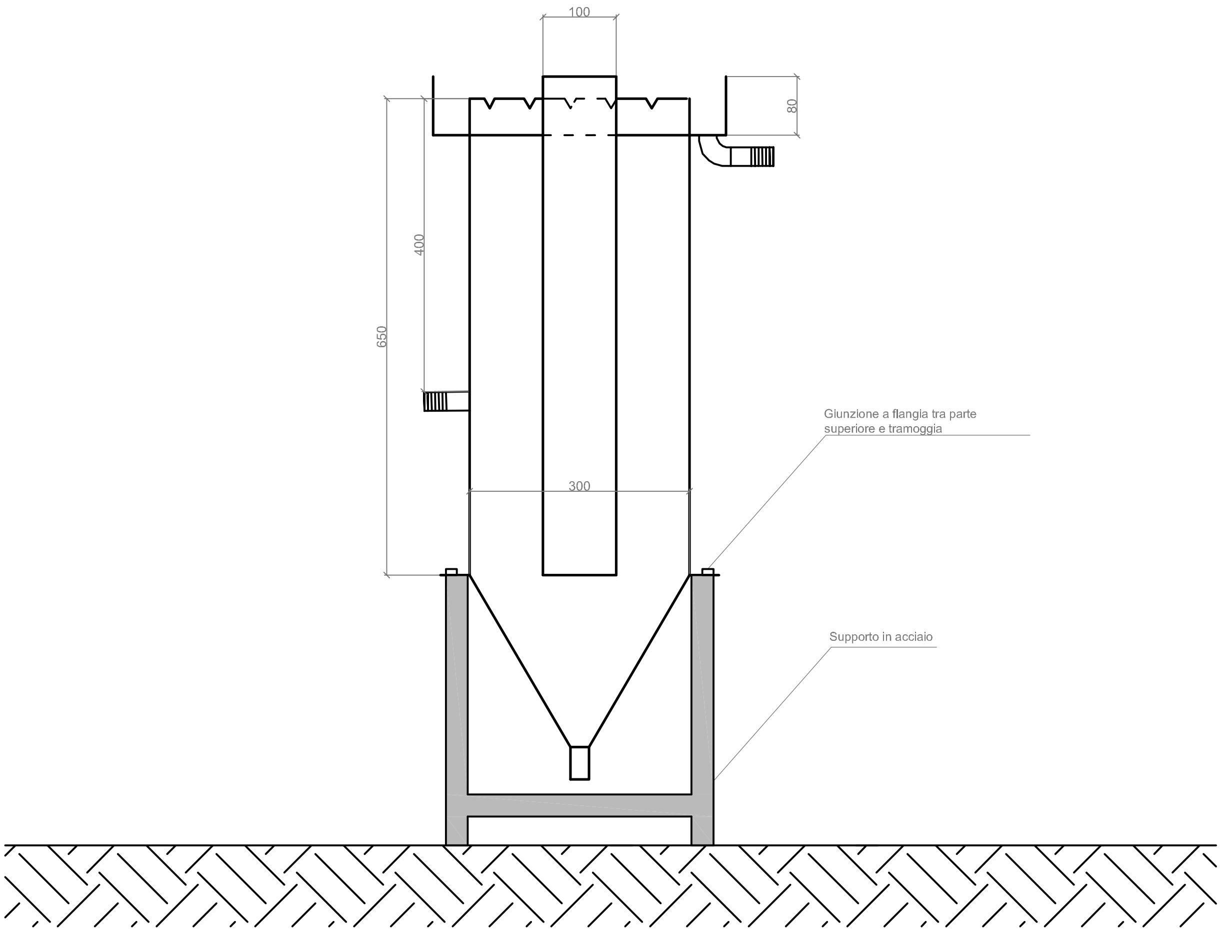


# Sedimentatore schema OSA

## Pianta



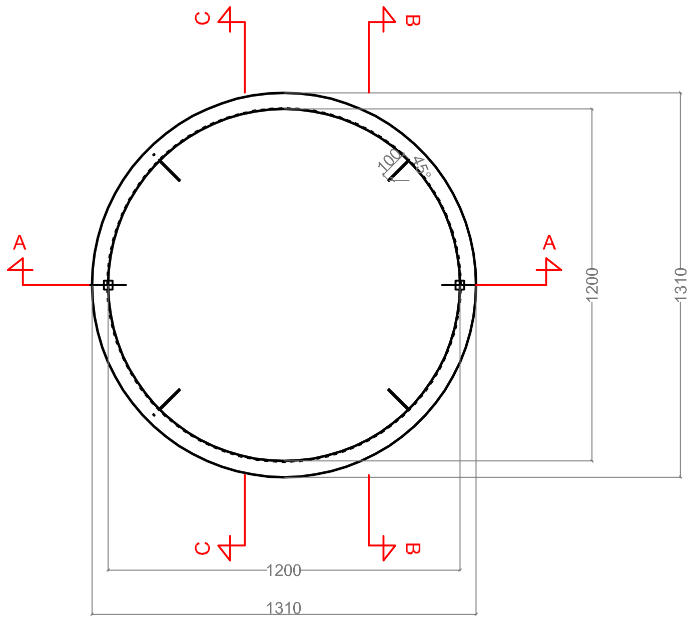

## Sezione A-A




Foglio A4 - Scala: 1:10

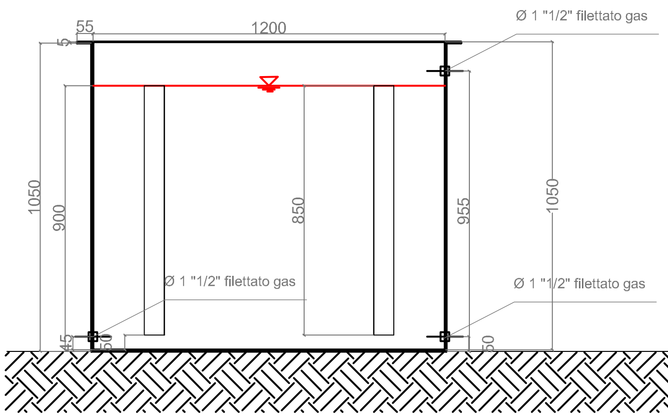
# Vasca refluo di alimentazione

## Pianta

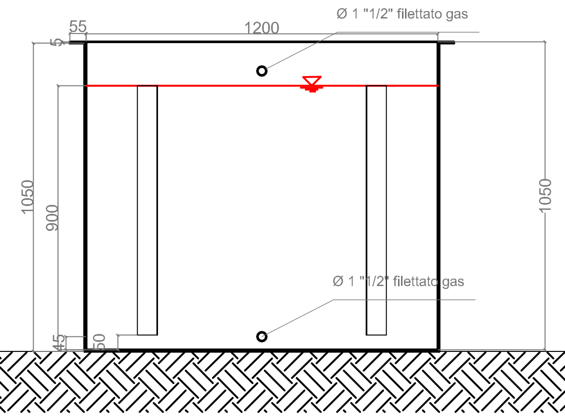



Foglio A4 - Scala 1:25

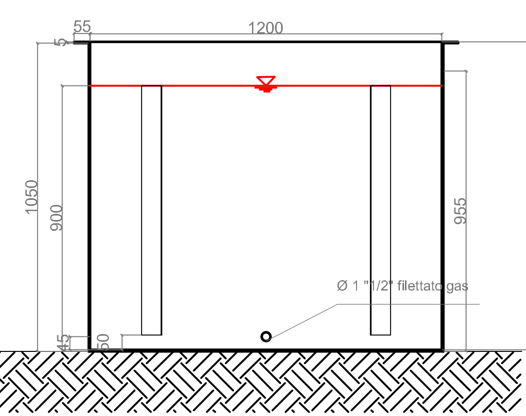
### Sezione A-A




### Sezione B-B



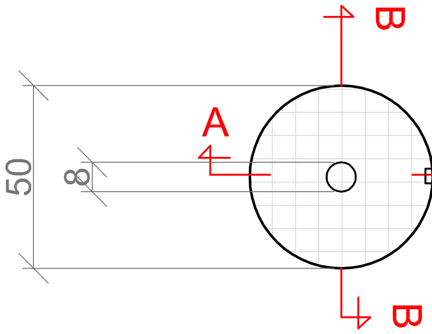

### Sezione C-C



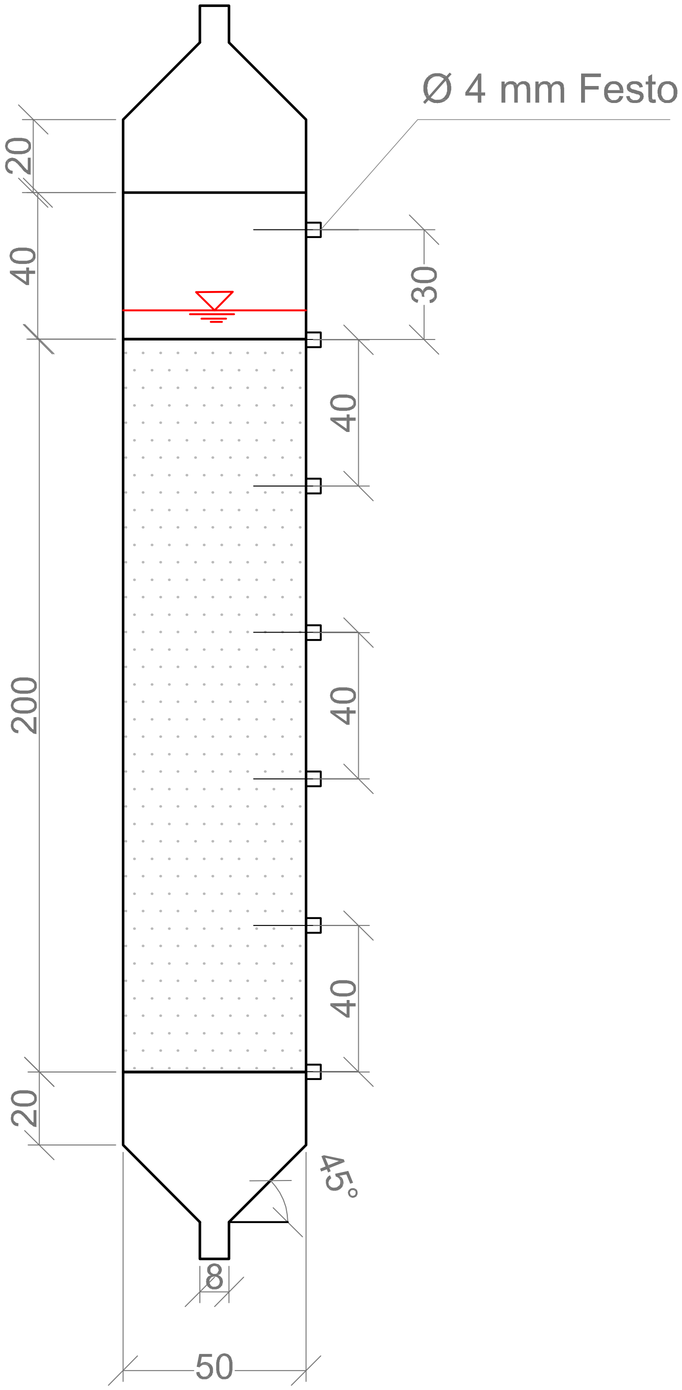
# Colonna zeolite/biochar bench scale

Foglio A4 - Scala: 1:2

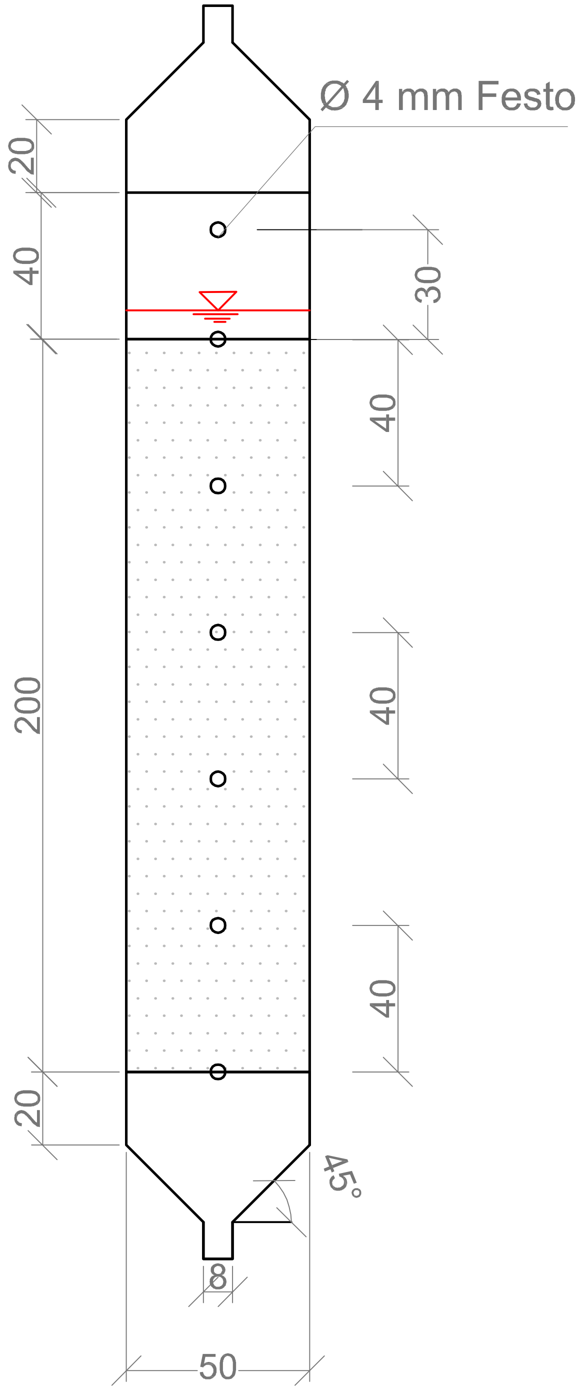
## Pianta




## Sezione A-A



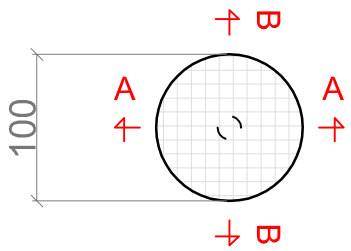

## Sezione B-B



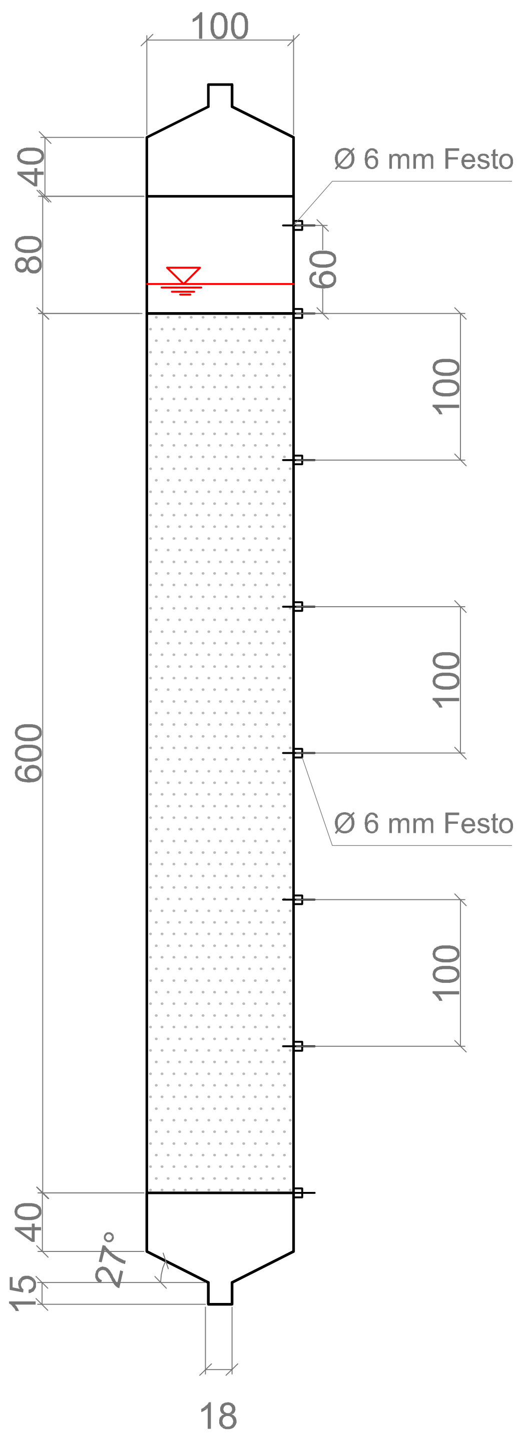
# Colonna zeolite/biochar pilot scale

Foglio A4 - Scala: 1:5

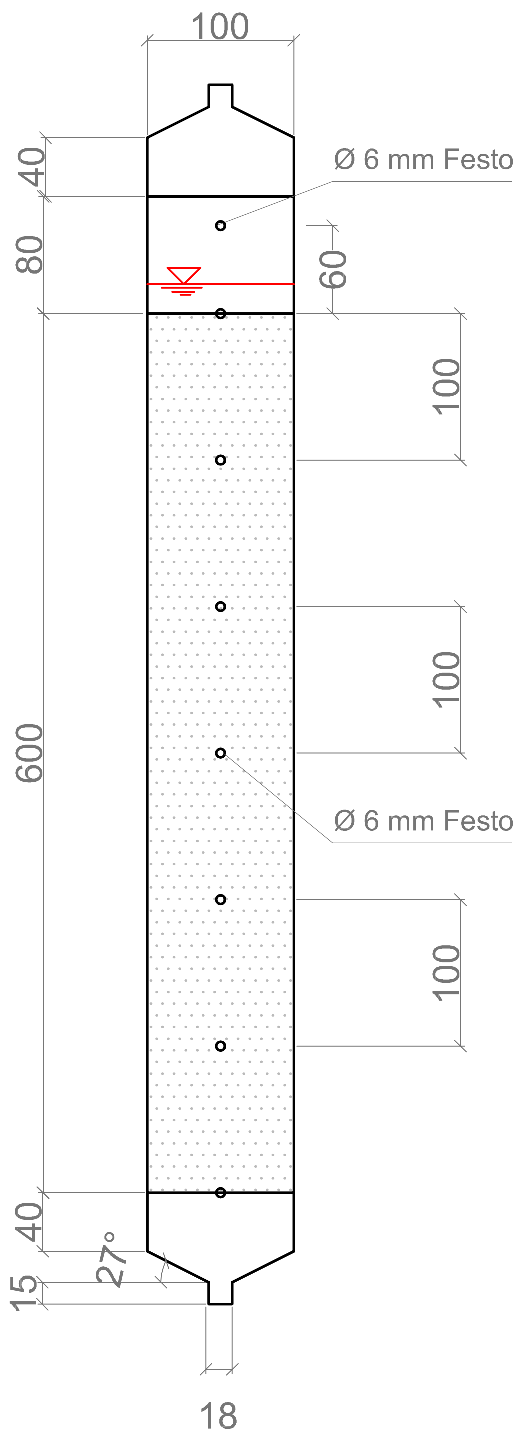
## Pianta




## Sezione A-A

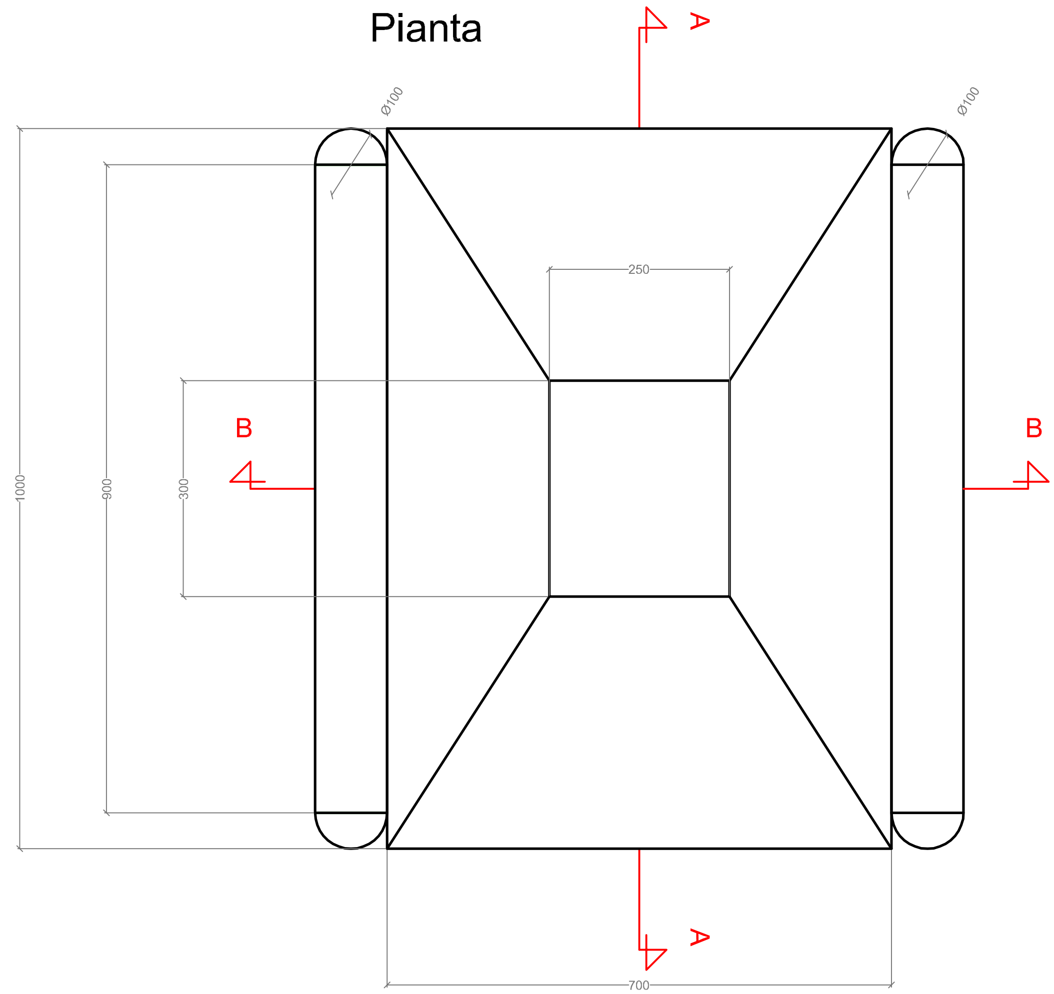



## Sezione B-B

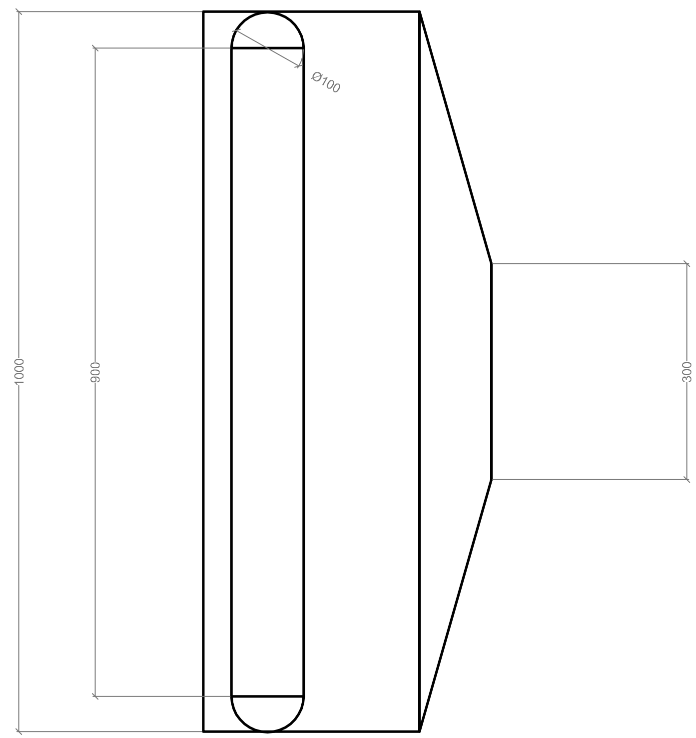


# Cappa biogas

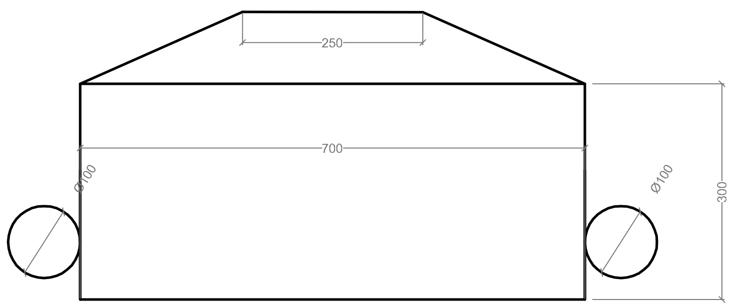
Pianta




Sezione A-A




Sezione B-B




Foglio A4 - Scala: 1:10