LIFE Project Number

**<LIFE +10 ENV/IT/000394/WARBO>**

# FINAL Report

**Covering the project activities from 01/01/2012 to 31/12/2014**

Reporting Date

**<31/03/2015>**

LIFE+ PROJECT NAME or Acronym

**<WATER RE-BORN - Artificial Recharge: Innovative Technologies for the Sustainable Management of Water Resources>**

## Annex 55

Name of Deliverable:

Risultati del monitoraggio dell'efficacia delle nuove tipologie di Pozzi mirati a ottimizzare la R.A. con il protocollo multidiscipplinare WARBO

Code of associated action: 4,5,6,7,8,9,10,12

# Risultati del monitoraggio dell'efficacia delle nuove tipologie di Pozzi mirati a ottimizzare la R.A. con il protocollo multidiscipplinare WARBO

## 1 Introduction

This document was expected to be necessary in an early phase of the project, still when injection wells for MAR, were predicted to be built under the framework of the WARBO project. However during the project implementation, legal constrains forced the change of the recharge concept to dispersion methods such as infiltration basins, and rendered the recharge wells project obsolete. The only wells built were for monitoring purposes (piezometers).

## 2 Injection wells project

The partner Botti Ellio perfurazione developed a model for the recharge wells focusing on the cleanliness of incoming water, to avoid clogging. The biggest problem with re-entry wells in fine ground does not concern its capacity to receive or release water, rather, it is centered around the selection of the most suitable filter. Well experts are well acquainted with the saying 'the more it drinks the more it releases', concerning circulation loss during perforation. Re-entry water often contains elements which, if oxidized or heated, expand, leading to mineral deposits and build-up in tubes. This causes a gradual slowing down of entrance flow which then leads to complete blockage.

Terrain characterized by highly permeable gravel aquifers is rarely, if at all, affected by this problem given that filter openings are much wider and less susceptible to blockages

The prepared correspond to wells which work in exactly the opposite way of pumping wells. The well is perforated in the best possible way in order to prevent sand particles from entering before its completion. The perforation method must be chosen in accordance with the type of terrain. The feed column method is not always the most suitable.
The tubes in this type of well are identical to those used in normal wells, with filtering surfaces in the permeable parts and impermeable filters in the clay section. The type of filtering surface shall be chosen based on aquifer characteristics which are checked in a series of sampling activities carried out before the well is executed. Specifically, it is important that it provides the highest possible level of passage in relation to the external drain.

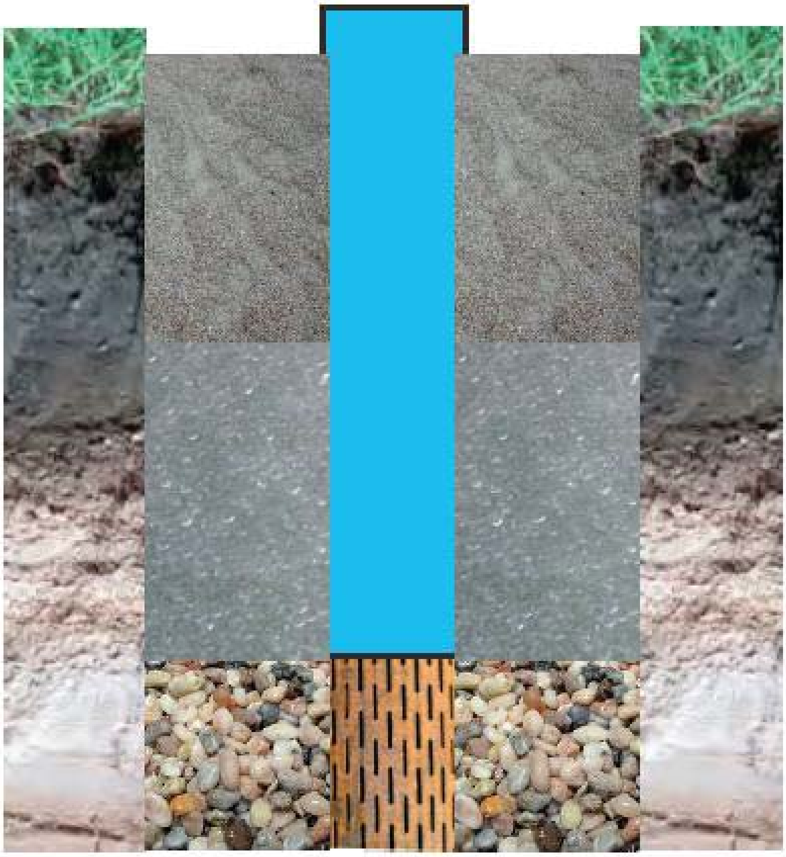

**Figure 1 – Infiltration well model**

The perforation should be filled with the utmost accuracy, in accordance with the filtering surfaces, rounded and course 5-8 'pea' type silicate draining should be used in ground as in this case, above a calibrated drain with glass spheres, with fine river sand at the very top.

Re entry water runs outside not inside tubes, the river sand removes initial impurities, the glass sphere drain facilitates water flow and avoids the formation of impurity bridges. The coarse drain thus remains clean and smooth over time and ensures the emission of clean water into the aquifer. The central tube ensures that backwash occurs, should the drain become blocked over time.

This type of laboratory-developed well has yielded excellent results over time, input capacity barely altered during the winter it was tested.

# 3 Piezometer construction

In the Mereto test site a total of 5 new piezometers were constructed. Three of those (A1, A2 and A3) were constructed for the microbiological monitoring, aiming to understand the effects of the vadoze zone. Instead these piezometers proved the existence of the perched aquifer. They were built with 3’’ diameter (PVC – casing), with the direct circulation method, followed by a well development. The piezometers reached a level of 8, 11 and 15 meters.

The other 2 piezometers were built for the main aquifer (fractured conglomerate) monitoring. They were initially tried to be built with the down-the-hole hammer technic, but the terrain conditions didn't allow it. Therefore, they were built with the direct circulation method and require a great deal of development in order to effectively measure aquifer levels and characteristics. Both piezometers have 60 meters depth and are screened from the 50 meters down.

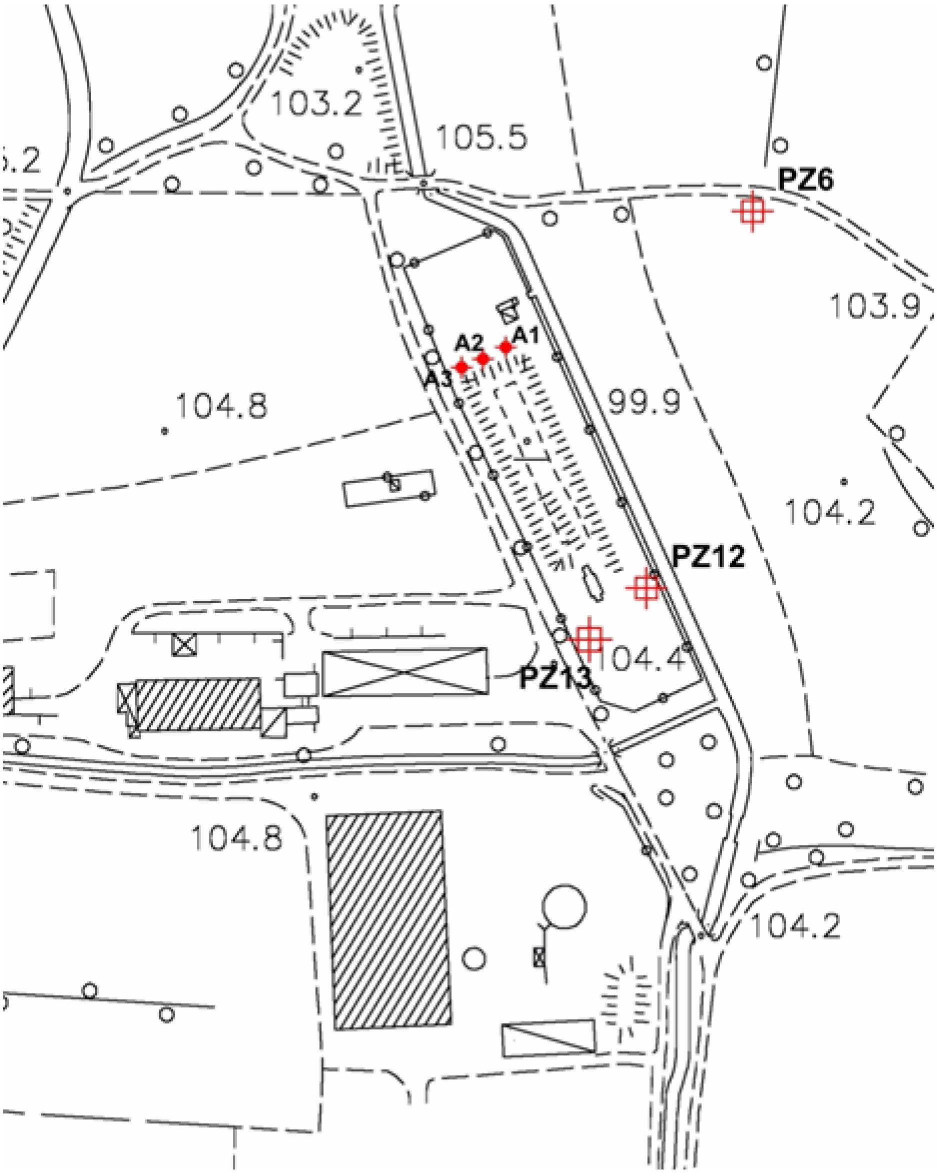


**Figure 2 – Location of Mereto new piezometers (A1, A2, A3, PZ12 and PZ13)**

In Copparo, a total of 7 piezometers were built. The first 2 (P8 and P9) were built in a location near the predicted place were the injection wells would have been placed. They were constructed with core sampling, which later were analyzed. They reached 50 meters depth with a 3'' casing. The P8 was screened in the deep salty aquifer (18, 27 and 42 meters), whereas the P9 was equipped with conductivity sensors in all its depth.

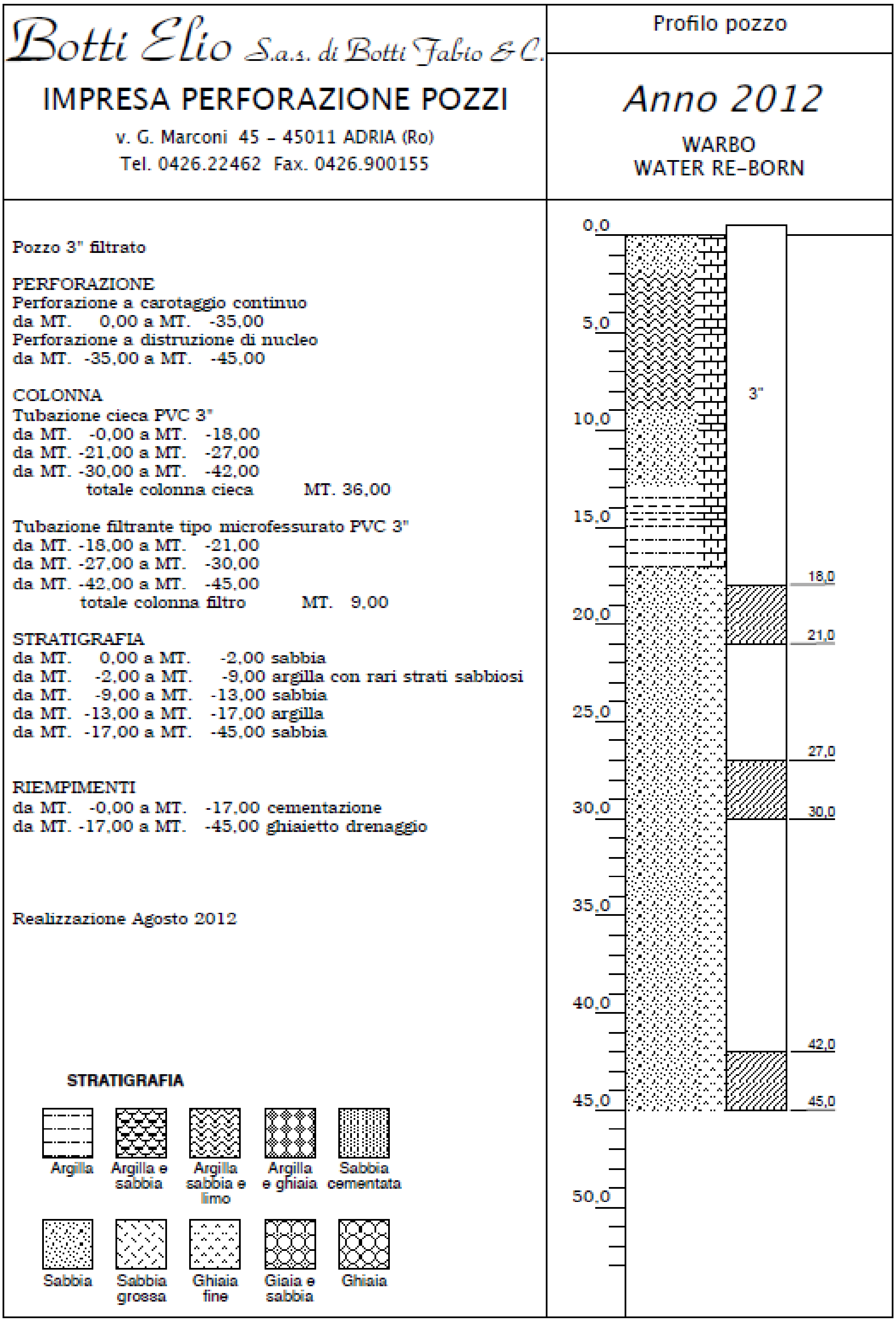


**Figure 3 – P8 Log**

The change in the recharge concept from the injection wells to the artificial lake asked for the construction of new piezometers in the vicinity of the pond. A total of 5 piezometers were built (P10 to P14) with the direct circulation method, to depth up to 20 meters, and screened in the paleochannel. The P14 reached 30 meters, didn't cross the paleochannel and it was screened in the salty deeper aquifer. All piezometers were cased with PVC 3’’ and pumping tests were conducted.