AQUOR PROJECT PILOT SITES

1. Carmignano di Brenta (PD): Forested Infiltration Area

2. Sarcedo (VI): Infiltration trench

3. Rosà (VI): Sub-surface infiltration field

4. Ancignano di Sandrigo (VI): Infiltration channel

5. Breganze (VI): Infiltration wells

1. FORESTED INFILTRATION AREA: CARMIGNANO DI BRENTA (PD)

Introduction

The pilot site has a Forested Infiltration Area constructed on private land (thanks to a multi-year agreement) that has been used to grow corn for the past twenty years. The forested area[2] comprises approximately 2,300 native plants mixed in various ways. These vegetation formations have a significant naturalistic value for the local ecological network, which is connected to the nearby "Grave e Zone Umide della Brenta" (Gravelly Flood Plains and Wetlands of the Brenta) Natura 2000 area.
The groundwater recharge system is located on a rural farm that is active in researching and implementing sustainable farming methods, and promoting these methods through educational initiatives. This provides a significant added value to AQUOR in terms of increasing awareness of the project.

Environmental sustainability:

- Increase in biodiversity – the creation of the forested area reintroduces a habitat that encourages certain plants and animals characteristic of the region to settle in the area;
- Water conservation – in contrast to farmland, the wooded area does not require irrigation (in this specific case, approximately 12,000 m^3 of water will be saved per year);
- Carbon dioxide fixation – over a 30 year period, an estimated 1,500 tCO_2 (approximately 50 tCO_2 per year) will be fixed;
- Protecting the landscape – the introduction of a new oak-hornbeam forest, which is typical of the Po Valley, will re-establish a historic landscape that has almost disappeared;
- Renewable energy – the woodland also provides a source of wood biomass for energy usage (due to the naturalistic character of the woodland, the wood biomass will only be for domestic use).

Social sustainability:

- Recreation and enjoyment opportunities – improvement of the area by restoring its natural value and offering environmental education initiatives to schools and local associations;
- Green areas for residents – the woodlands improve the quality of life for the local population.

Photo 13 - Improvement in the natural and landscape value of the project site

Location

The project site is located just North of the spring zone boundary in an agricultural setting on the right bank of the Brenta River, in the San Giovanni di Camazzole district of the municipality of Carmignano di Brenta (PD).
Coordinates: 45° 39′ 38″ N; 11° 41′ 08″ E

Water diversion

The supply of water to the Forested Infiltration Area is assured by an underground inlet pipe made of vibration compressed concrete that connects to the existing irrigation channel (Bocchetto San Giovanni Grimana Nuova) via an intake structure equipped with an adjustable sluice-gate.

[2] Forestation of the Forested Infiltration Area was not part of the AQUOR project, but rather was already planned as part of an environmental improvement project whose financing was provided for in the Veneto Rural Development Plan 2007-20013, Measure 221 (initial reforestation of agricultural land), Action 1 (permanent woodlands). During implementation, coordination activities ensured optimization of both projects and the establishment of a synergistic relationship.

Photo 14 - Existing irrigation channel

Description of the system (structure and size)

The pilot system has two infiltration areas that feature a total of 10 longitudinal infiltration channels having a sinusoidal shape with wide curves. The channels each have a length of approximately 93 meters and are spaced about 14 metres apart (interaxial). Four of these channels run East-West (first area) and six run North-South (second area). Water is evenly distributed in the recharge area by means of a water level regulation system, which divides the available flow equally among the individual infiltration channels.

Each infiltration channel has water level control structures that are spaced 30 meters apart. These structures enable the system to form a 'reservoir', which improves the efficacy of the infiltration.

Upstream of the recharge area, there is a sediment trap, or rather a small pool with a surface area of approximately 50 m^2 where sedimentable suspended solids present in the intake water are deposited. This reduces blockages of the channels and ensures a longer useful lifespan for the system.

The excess excavated dirt was used to create a rise on the North-western side of the infiltration area, providing a visual and acoustic barrier between the forested area and the adjacent public road.

The forested area is a naturalistic woodland that consists of sections of four parallel rows of vegetation alternating with channels. One row of each section is destined for periodic cutting (to permit maintenance of the channels by the Brenta Drainage Authority), while the other three contain tall trees. Hazelnut, alder buckthorn, common buckthorn, blackthorn, wild privet and cornel trees were planted along the exterior borders of the woodland. The rows parallel to the channels, which are also sinusoidal, are planted in two different ways. The rows that are to be periodically cut (located to the South or the East, depending on the area) contain alternating secondary tree species (narrow-leafed ash and common hornbeam) that can be cut as required for maintenance. In the three central rows of tall trees, primary tree species (common oak, durmast oak, common ash, field elm, poplar and linden) alternate with secondary species (narrow-leafed ash and common hornbeam).

The rows are spaced 3 metres apart, and the plants in each row are also spaced 3 metres apart. After cutting, the equipment used to maintain the channels will therefore have a 4.5 metre strip in which to operate. The same width will also be available for the cutting work itself, permitting easy execution of the related operations.

Photo 15 - Forested Infiltration Area system just after completion

Photo 16 - Detail of sediment trap – under construction

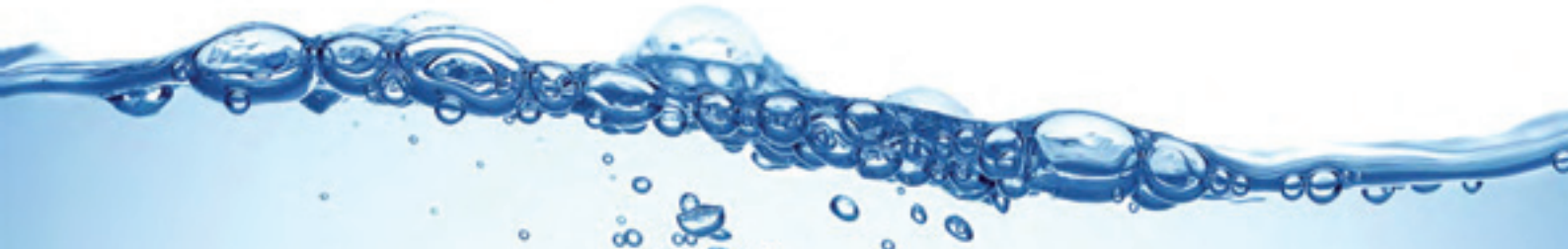


Figure 8 - Plan of the educational/natural Forested Infiltration Area

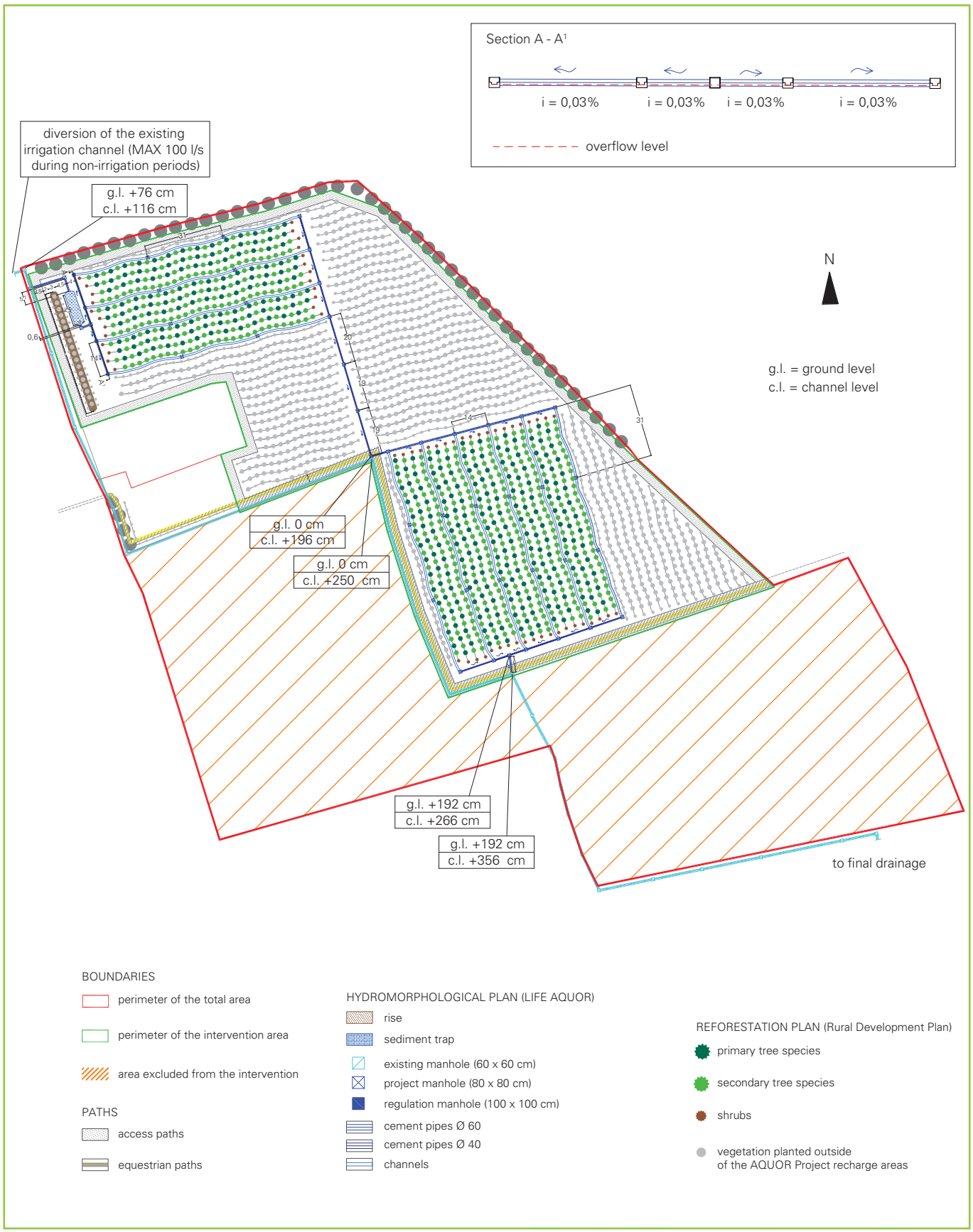


Figure 8a - – Detail of the North area of the educational/natural Forested Infiltration Area

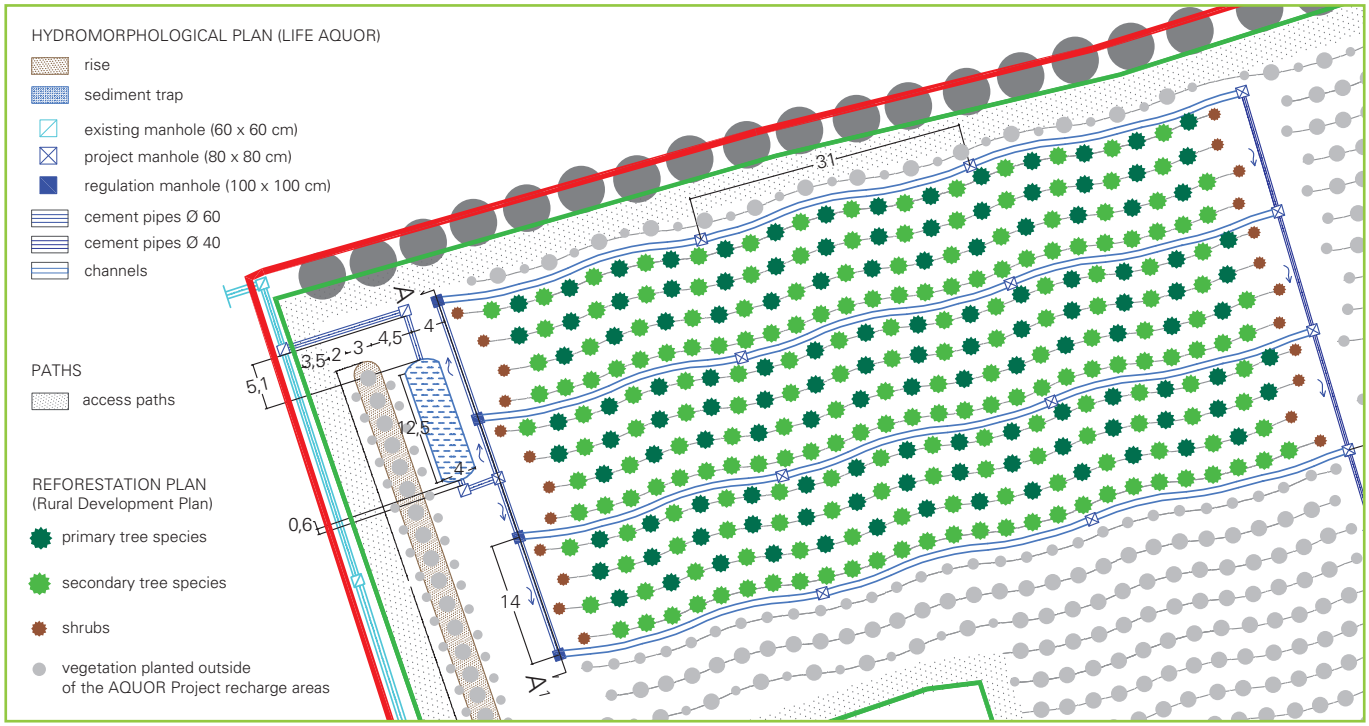
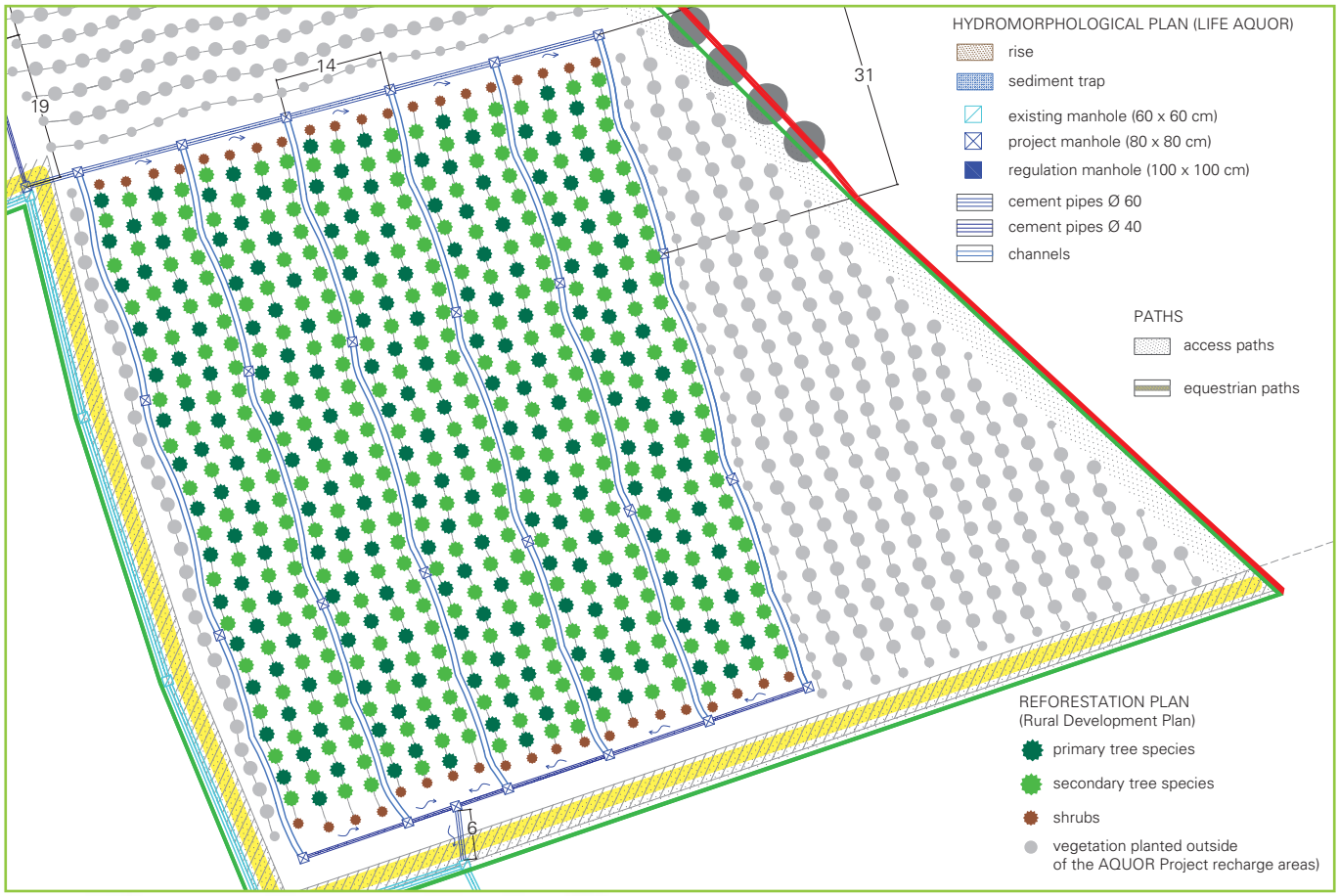


Figure 8b - – Detail of the South area of the educational/natural Forested Infiltration Area



2. INFILTRATION TRENCH: SARCEDO (VI)

Introduction

This pilot site uses an infiltration trench as the groundwater recharge method. The project site, located on municipal land, is currently a green area for public use with walking paths and recreational equipment. The area already contains four experimental infiltration wells, which were constructed outside of the AQUOR Project by the Consorzio di Bonifica Alta Pianura Veneta (Veneto Upper Plain Drainage Authority), in agreement with the Province of Vicenza. The proximity of the AQUOR system to these existing recharge works enables the value of the public space to be further enhanced by creating an educational park that focuses on the importance of underground water resources.

Location

The site is located inside a green public area owned by the municipality of Sarcedo (VI) that is equipped as a public park.

Coordinates: 45° 41′ 41″ N; 11° 32′ 04″ E

Photo 17 - Verlata Channel and the area before intervention

Water diversion

The donor water body for the recharge project is the Verlata irrigation channel, which runs alongside the area of interest. This channel, in turn, is diverted from the Mordini irrigation channel with a surface intake from the Astico stream in the Molini district of the municipality of Zugliano (VI). During non-irrigation periods, an estimated discharge of up to 700 l/s can be diverted from the irrigation channel. Also during non-irrigation periods, the existing infiltration wells distribute a flow of approximately 500 l/s, so there is up to 200 l/s of discharge available for the trench. The infiltration trench is fed by a 500 mm concrete gravity inlet pipe, attached to an existing diversion pipe (that brings water from the channel to the wells) by means of a concrete separator with overfall divider. The inlet pipe, in turn, is connected to 3 distribution wells located before the trench that evenly divide the available flow among the infiltration lines.

Description of the system (structure and size)

The infiltration trench consists of an excavated area with a trapezoidal cross-section and sides that have a slope of 3:1. It has a useful depth of 3 metres (depth required to intercept the fourth soil horizon, which is the most permeable) a width of 10 metres and a length of approximately 60-70 metres. The distribution lines, two 300 mm micro-perforated cement pipes, are placed on a bed of gravel at a depth of approximately 260 cm, covered with coarse materials (oversized gravel and stones from the excavation work). The remainder of the excavated trench is filled with other material and then covered with a layer of vegetated soil that is approximately 50 cm thick. In order to monitor water levels, four 100 mm monitoring piezometers with sealed covers are placed equidistantly along the length of the infiltration trench. In addition, a masonry structure called the "Observatory" was created to allow visual inspection of the trench for educational purposes. It features a layered glass cover and is built of riven finish stone using semi-dry set techniques.

Photo 18 - Diversion pipe

Photo 19 - Construction of the trench (placement of the distribution wells)

Photo 20 - Construction of the trench (note the two infiltration lines)

Photo 21 - Construction completed, restoration of the field

Photo 22 - Educational observatory

Figure 9 - Cross-section of the infiltration trench and profile of the undisturbed subsoil (section A - A[1])

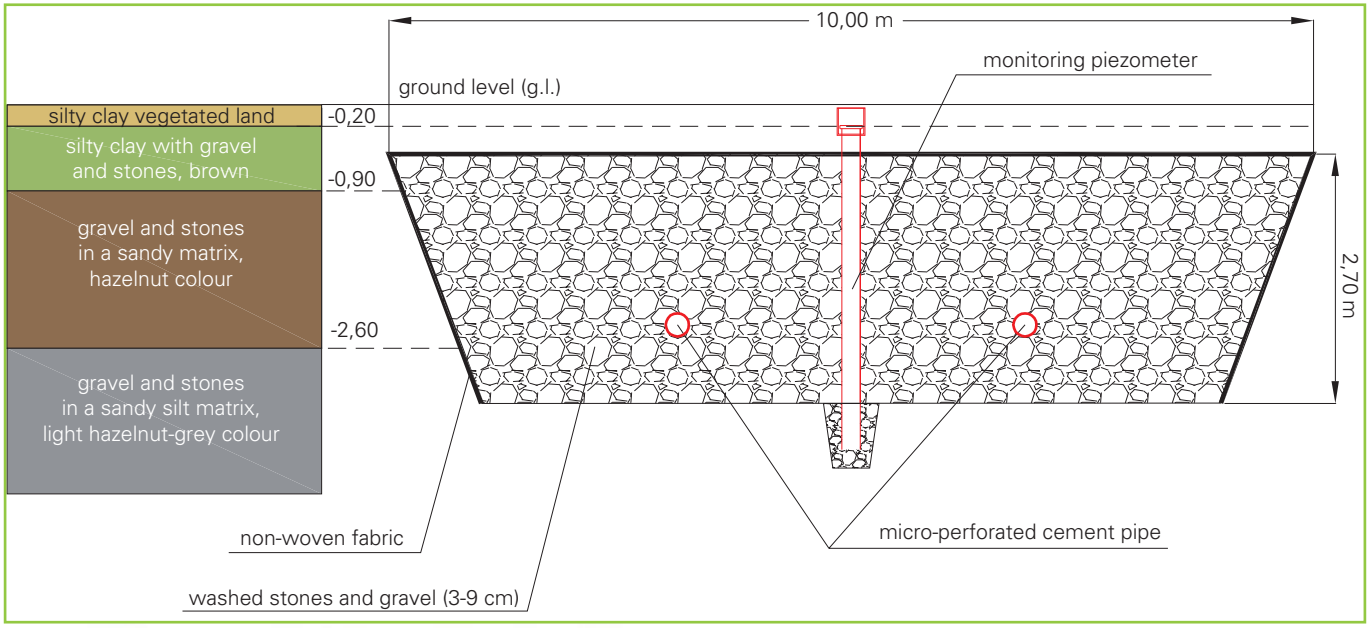
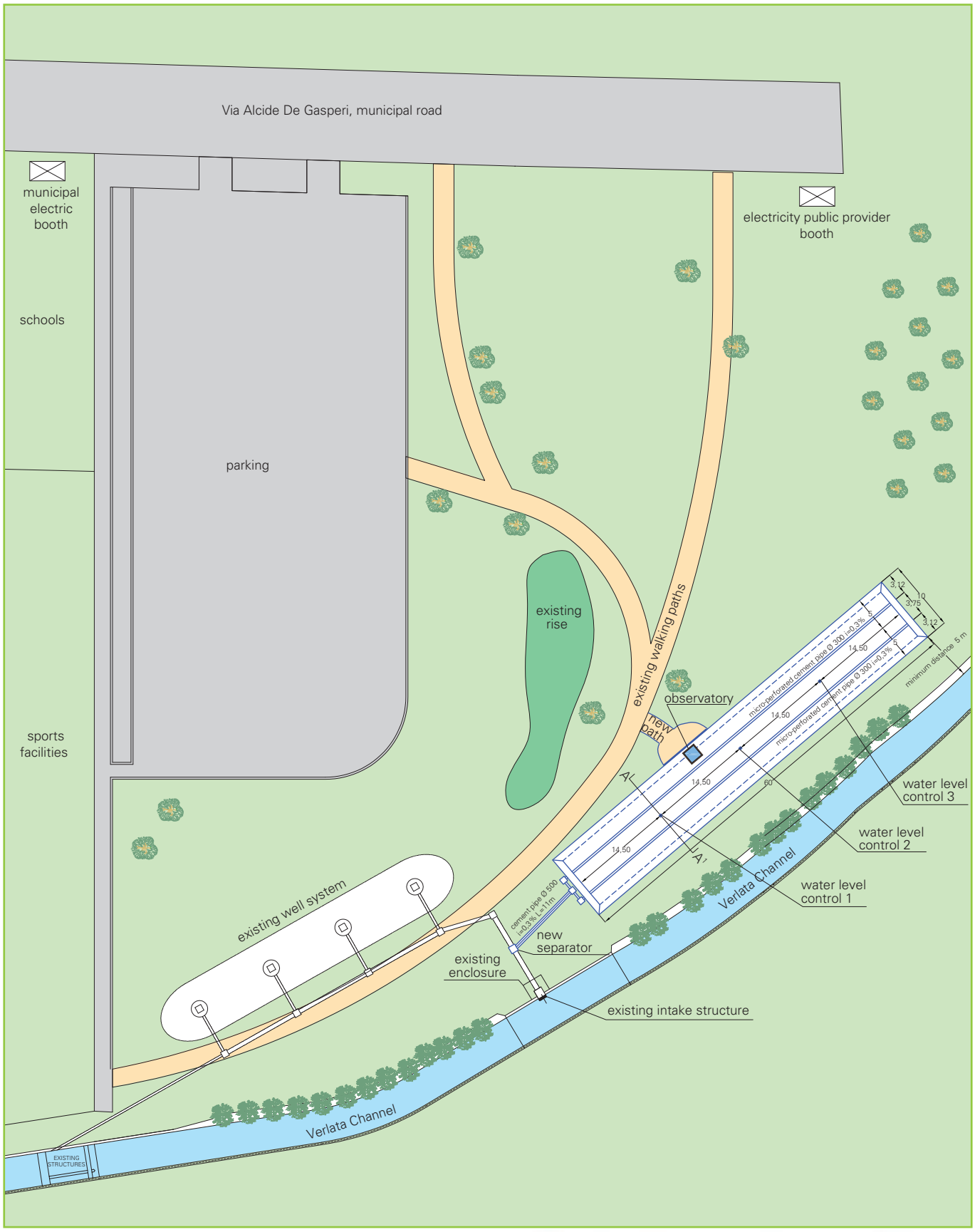


Figure 10 - Descriptive diagram of the infiltration trench



3. SUB-SURFACE INFILTRATION FIELD: ROSÀ (VI)

Introduction

The pilot site has a sub-surface infiltration field composed of an inverse drainage system placed beneath agricultural land that permits sub-surface water infiltration.

Location

The project site is located in the municipality of Rosà (VI). From an urban planning perspective, the area is classified as "primarily for agricultural use". It is bordered to the South by a local road, and on the other three sides by agricultural land that is also located in Rosà. The site is an elongated rectangular section of an agricultural field that runs NNW-SSE.

Coordinates: 45° 42′ 25″ N; 11° 44′ 46″ E

Water diversion

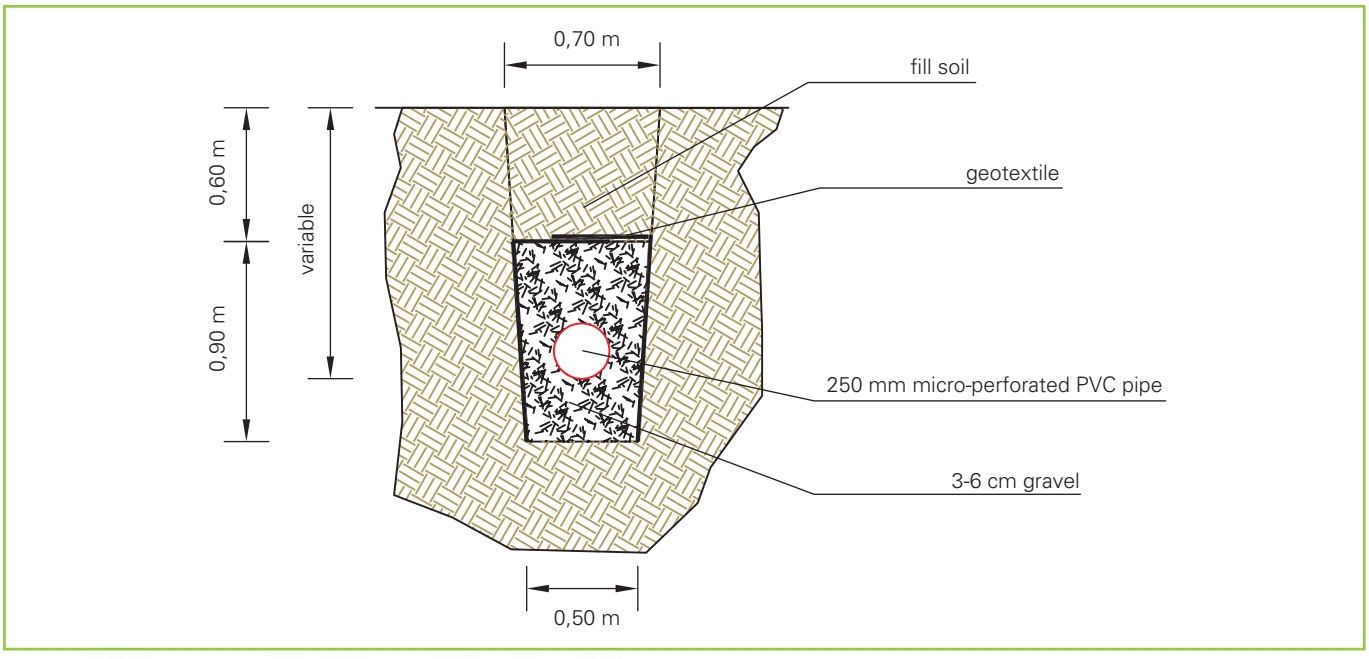
The water for the infiltration project is provided by the existing consortium irrigation network (Brolla Channel), which flows approximately 100 metres to the West of the site. The water is carried to the sub-surface infiltration field by means of a cement channel that connects to the Brolla Channel via an irrigation inlet located on the northern side of the property.

At the North end of the system, there is a diversion structure with a metal sluice-gate that connects the distribution channel to the sub-surface infiltration network. Downstream of the diversion structure, a distribution well is connected to two supply channels that divide the available flow equally among the infiltration lines.

Description of the system (structure and size)

The sub-surface infiltration field is composed of two trenches (holding trenches) having a trapezoidal cross-section, a depth of approximately 90 cm and a width at the base of approximately 50 cm. Each trench holds a 250 mm micro-perforated PVC infiltration pipe placed at an incline of between 0.2% and 0.5%. Each pipe is approximately 200 m long (total 400 m of sub-infiltration line) and is interrupted by inspection manholes spaced approximately 25 metres apart. At these junctions, 160 mm PVC micro-perforated pipes measuring 9 m each branch off from the main line. The infiltration pipes rest on a 30 cm thick bed of gravel (3 - 6 cm), consisting of stone that was screened and carefully arranged in layers in the excavation trench. Above the gravel, the trenches

Figure 11 - Cross-section of sub-surface infiltration trench



are filled with soil from the excavation. The system is designed to efficiently allow infiltration of a flow of 20 l/s (over an infiltration surface are of approximately 20 m^2), which the Brenta Drainage Authority has estimated as the quantity of water available to the recharge site during the non-irrigation season. The infiltration area available is 64 m^2 and can eventually handle more water than the amount currently planned. The system can therefore also tolerate any localized clogging[3] that may occur, which causes a natural decrease in the localized infiltration capacity.

The system does not require continuous management. Periodic inspections are made to ensure that the gravel and surrounding soil are not clogged and that there is no standing water on the surface. This system enables prime artificial groundwater recharge land to be utilized while leaving the surface land use unaltered, making it possible to continue farming the land even during the recharge periods.

Photo 23 - Excavation to lay the sub-surface infiltration pipes

Figure 12 - Plan of the sub-surface infiltration field

[3] Obstruction of the porosity of the soil through which the water percolates due to the deposit/accumulation of fine sediments and organic residues.

4. INFILTRATION CHANNEL: ANCIGNANO DI SANDRIGO (VI)

Introduction

The pilot site features an infiltration channel with a sinuous shape that was newly excavated along the right bank of the existing consortium waterway (Vitella Channel), which is managed by the Brenta Drainage Authority. The site is a wildlife corridor that serves multiple, interrelated functions, including groundwater recharge, increasing phytoremediation capacity, creation of new wildlife habitat and, to a lesser extent, with respect to hydraulic safety, flood attenuation and dissipation of the erosive energy of the water flow. By diversifying the cross-section of the channel and planting vegetation alongside it, the flow velocity of the water that enters the area is reduced. This leads to an increase in the residence time of the water and has positive effects on both the quality and quantity of infiltration water.

Photo 24 - Vitella Channel

Location

The project site, which is located in the Ancignano district of the municipality of Sandrigo (VI), is a long rectangular plot (approximately 300 m x 10 m) of agricultural land that runs NNE-SSW and that has been used in recent years to cultivate corn. The plot is bordered to the West by a single row of harvestable water-loving trees along the Vitella Channel, to the South by a municipal dirt road and to the other sides by agricultural land that usually grows arable crops.

Coordinates: 45° 39′ 48″ N; 11° 38′ 45″ E

Water diversion

The water for the new infiltration channel is supplied via an inlet structure (equipped with an adjustable metal sluice-gate) on the irrigation canal connected to the Vitella Channel, located approximately 60 m upstream with respect to the North-eastern corner of the system. Downstream of the channel, the outlet system consists of an adjustable cement structure equipped with an overfall sluice-gate that returns any excess water to the existing irrigation system.

Description of the system (structure and size)

The entire length of the new watercourse (approximately 225 m) has a sinuous shape and features vegetation on both banks.

Along the initial stretch starting from the North (approximately 25 m), the left bank has two out-of-phase rows spaced 50 cm apart, with shrubs placed every 1.5 m. Specifically, cornel trees are planted towards the path, while purple osiers are planted on the side facing the canal. The West bank, on the other hand, has a row of dogwood spaced one metre apart. After the first 25 metres, shrubs are planted on both banks (dogwood, blackthorn, common buckthorn, wild privet, cornel trees, wayfaring trees and water elder). On the interior of the meanders, cherry plum, crab apple and field maple saplings were planted. A 40 m long island was created in the watercourse and planted with one alder every 5 metres (6 in total), alternating with groups of briar (one every metre).

The initial and final sections of the island and some sections of the facing banks, have water-loving herbaceous plants (sedge, orris) planted in two staggered rows and spaced 30 cm apart in each direction.

Figure 13 - Construction of a new, naturalistic infiltration channel; original condition

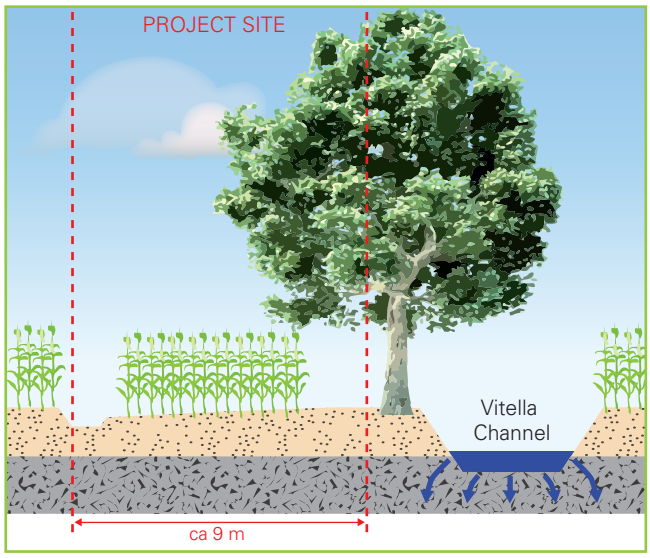


Figure 14 - Experimental site during construction

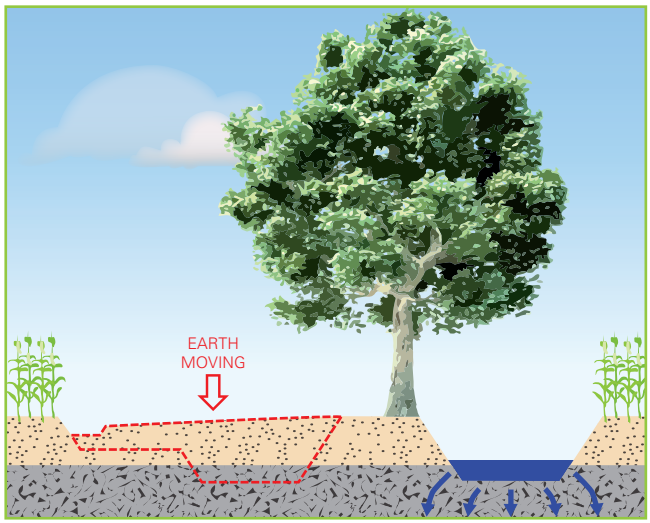


Figure 15 - Experimental site after completion

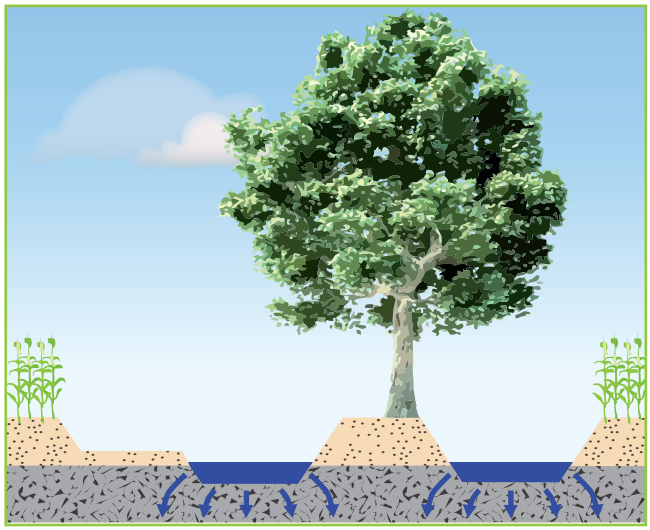


Photo 25 - Surface planted with corn before intervention

Photo 26 - Earth-moving activities for the creation of the new channel

Photo 27 - After construction with vegetation planted

Figure 16 - Plan of the site for the new infiltration channel

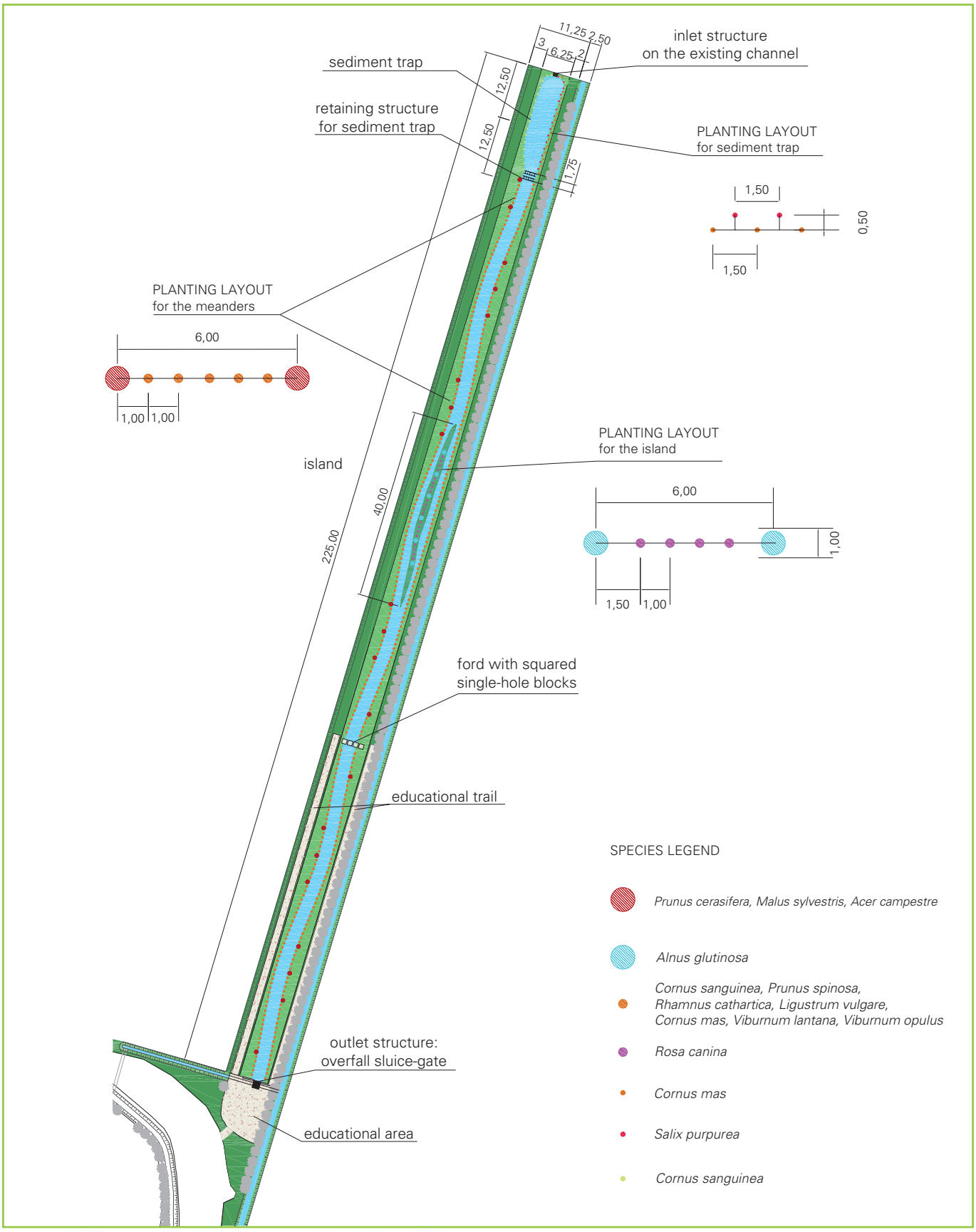


Figure 16a - Detail of sediment trap and a meander in the infiltration channel

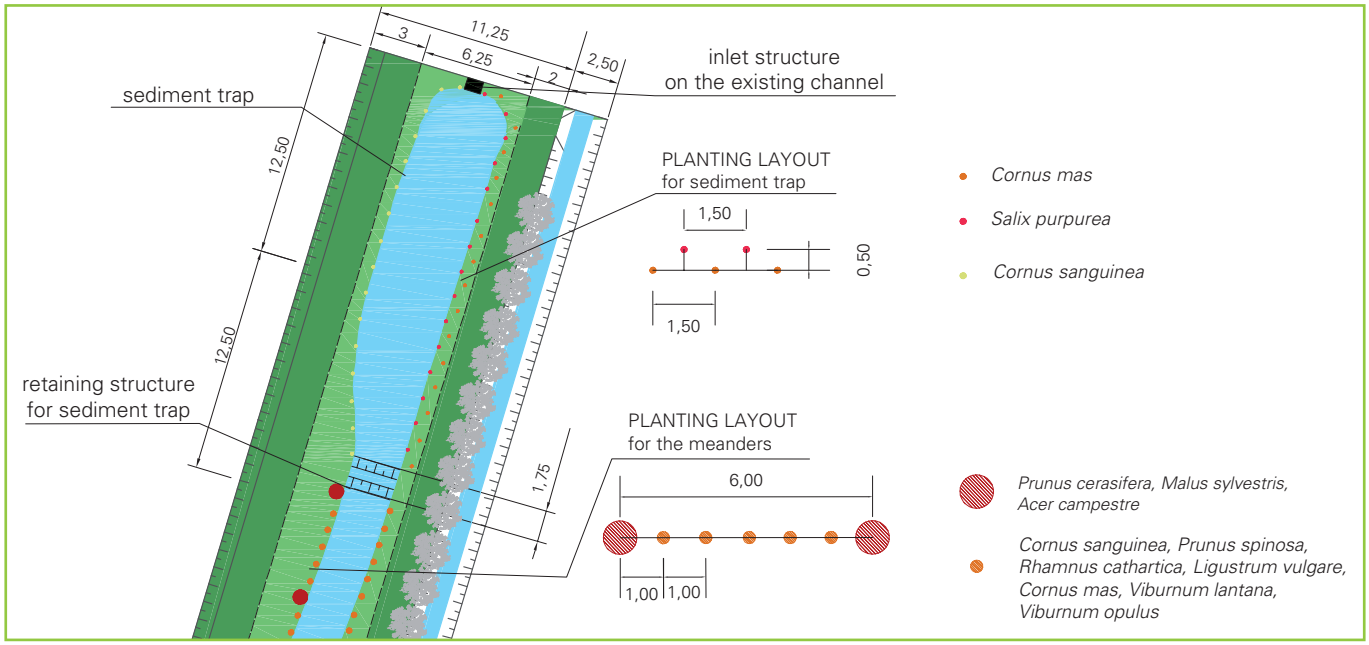
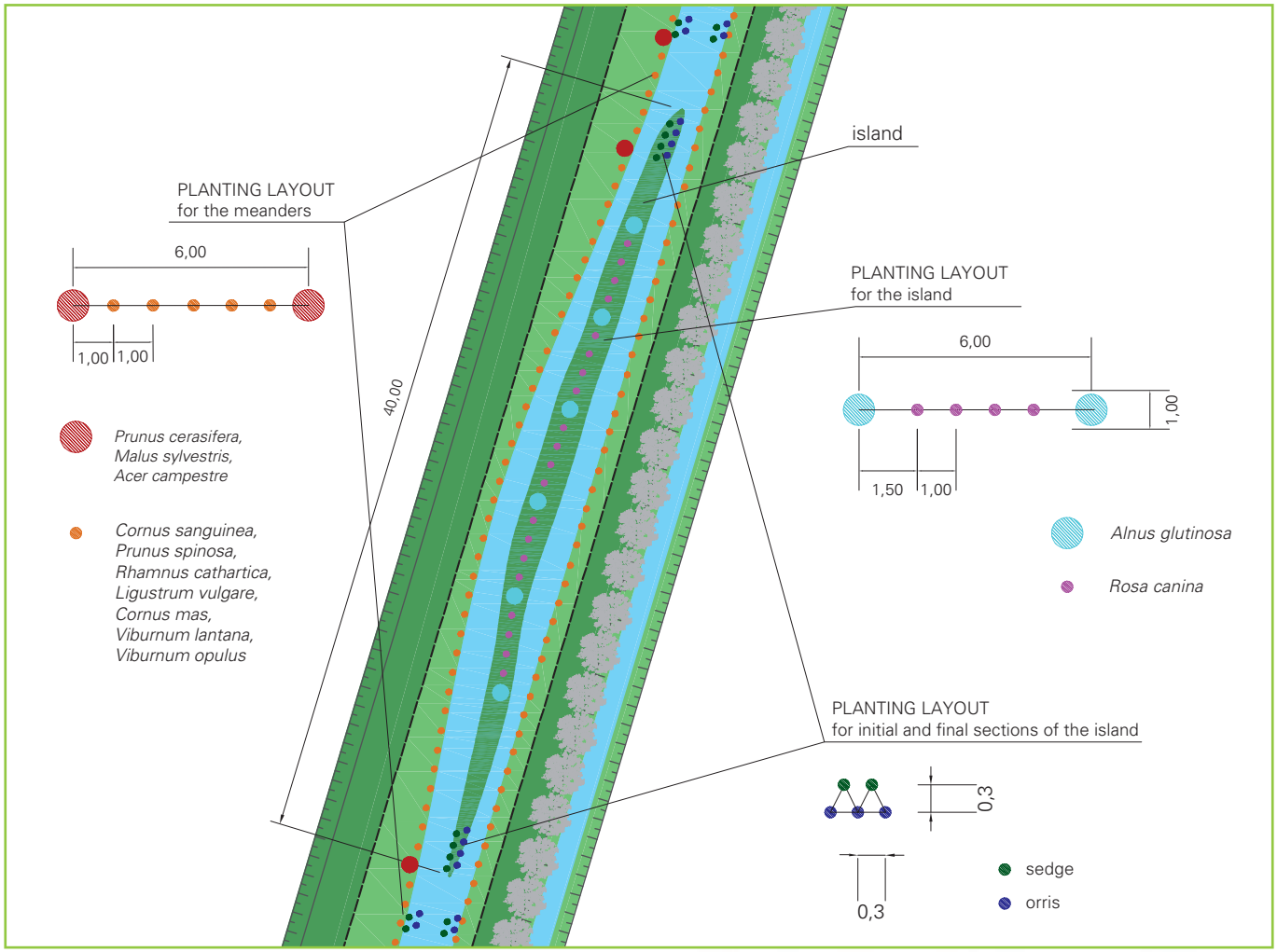


Figure 16b - Detail of the island and two meanders in the infiltration channel



5. INFILTRATION WELLS: BREGANZE (VI)

Introduction

The pilot project makes use of infiltration wells. It consists of a system of four vertical wells that are designed to convey and disperse water diverted from the existing channel into the subsoil.

Location

The project site is situated in an area used as a public park called "Baden Powell" in the Maglio district of the municipality of Breganze (VI), located along the Breganze Channel. The exact placement of the infiltration well system in the park was decided based on the following criteria:

- Least impact on the usability of the park;
- Ease of access for maintenance equipment;
- Proximity to existing educational area.

Coordinates: 45° 41' 54" N; 11° 33' 14" E

Water diversion

The wells are supplied with water via an intake structure (pre-fabricated box-shaped cement structure measuring 100 x 75 cm, suitably moulded) located along the existing irrigation channel that flows a few dozen metres to the East of the site. The box-shaped structure is placed even with the base of the channel and has a bottom threshold 10 cm from the base. The structure features a coarse grate to block transported material and is equipped with a steel sluice-gate to regulate discharge and stop intake during irrigation periods or during an emergency. The inlet structure enables a flow of 100 l/s (a value well below the discharge of the channel) to be taken from the channel during non-irrigation periods.

The water from the channel is carried to the wells by an intake line (500 mm cement pipe) placed at a depth of approximately 1.5 metres. A sand trap, a prefabricated box-shaped cement structure measuring 150 cm high x 75 cm wide x 10 m long, is located upstream of the well area to prevent clogging of the infiltration bed by suspended materials during periods of rain.

Description of the system (structure and size)

The system consists of four infiltration wells that measure approximately 4 m deep with respect to ground level. The wells rest on a bed of gravel at the bottom of an excavated area, approximately 3 metres apart from one another at the corners of a square. Each well is made of perforated cement rings measuring 2 m in diameter and 50 cm tall, stacked on top of one another. Each well has a circular cement cover equipped with a manhole for inspection. Groundwater recharge occurs through the release of infiltration water at the bottom of the well and through the perforations in its walls. To facilitate water infiltration into the subsoil, quarry gravel having a granulometry larger than the perfora-

Photo 28 - "Baden Powell" park area

Photo 29 - Breganze Channel

tions is placed around the well, while the final metre of fill is excavation material. Each infiltration well receives the same flow (approximately 25 l/s), supplied by the distribution wells.

The installed system does not affect the use and enjoyment of the park. The inspection manhole covers for the distribution wells are the only visible evidence of the work.

Figure 17 - Structure to divert water from the channel

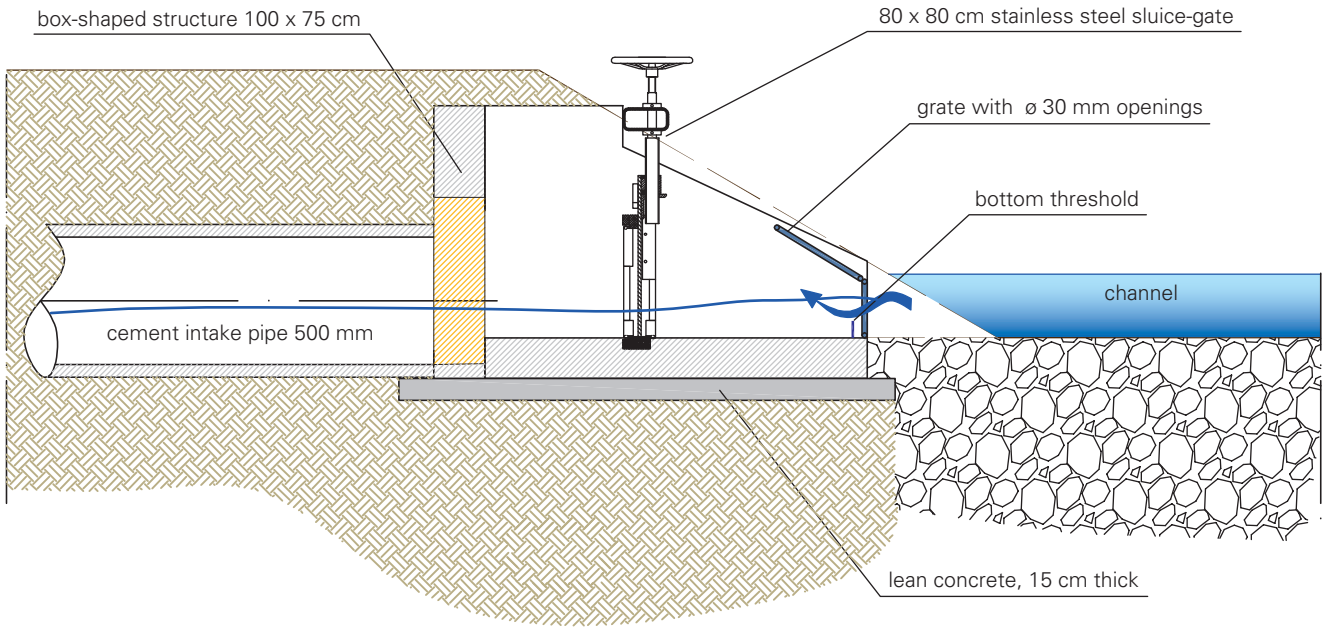


Figure 18 - Plan of the well system and diversion structure

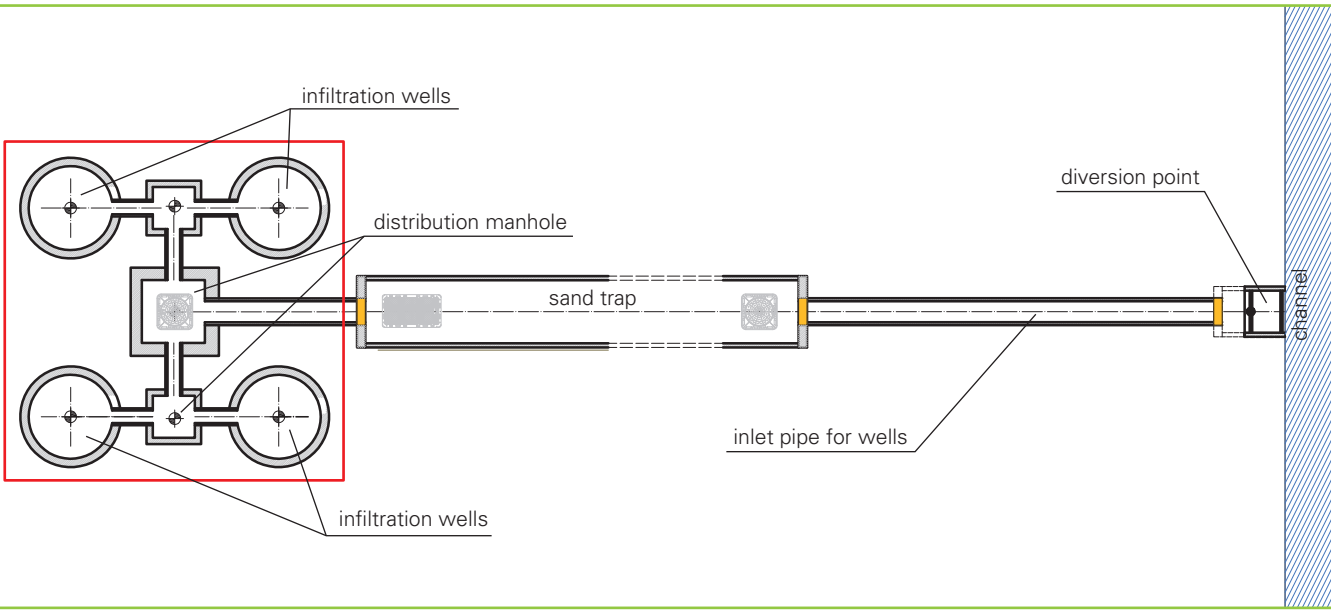


Figure 19 - Cross-section of the well system

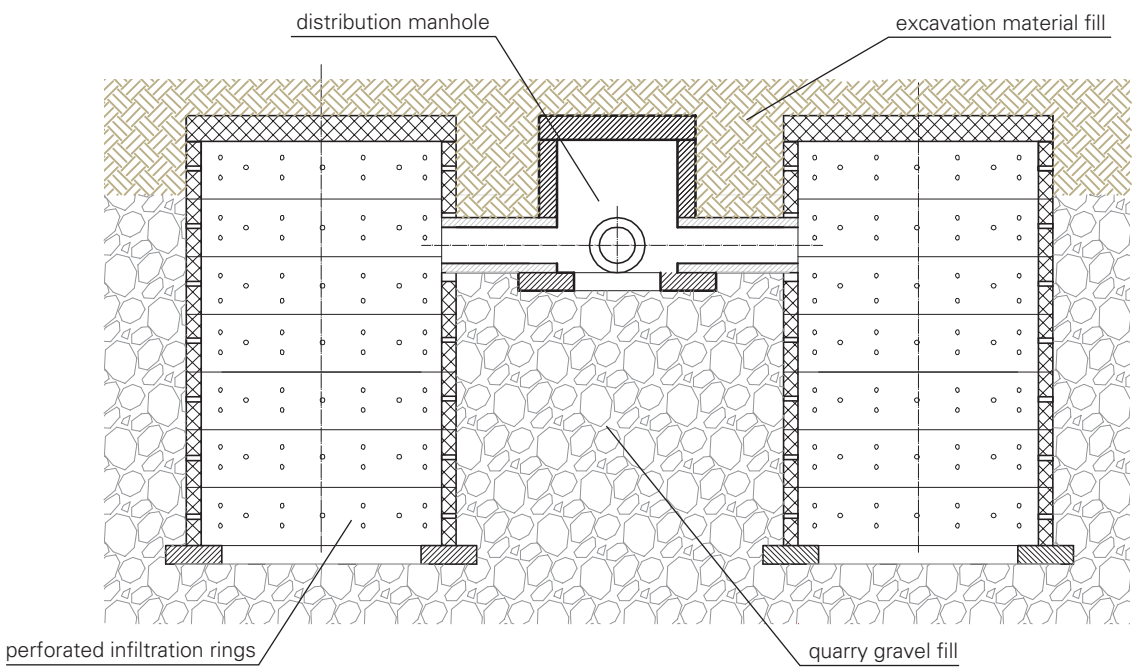


Photo 30 and 31 - During construction

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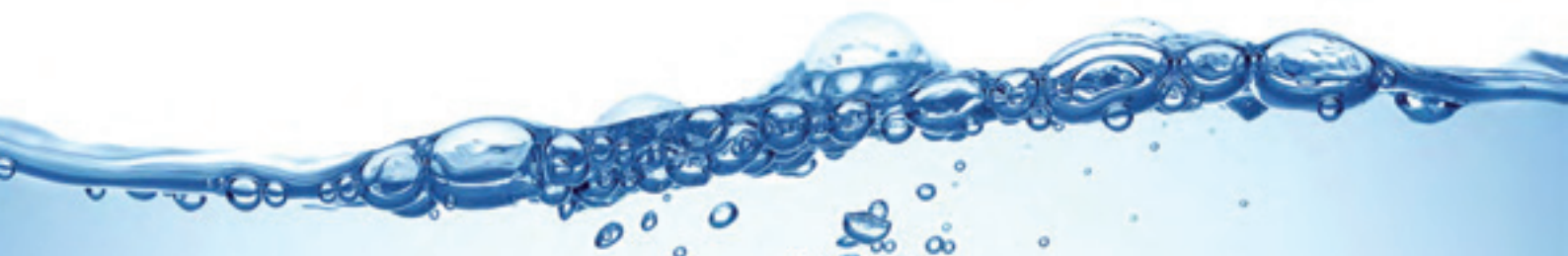

Project Coordinator

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