CASE STUDY

8

THE LANDFILL OF MONTESCHIANTELLO IN FANO (ITALY) REHABILITATION AND POST-OPERATIVE MANAGEMENT OF "BASIN 1"

1. Introduction

At the present moment, there are 8 active controlled landfill sites in the Marche Region (Central Italy). ASET is a joint-stock company whose major shareholder (97%) is the Municipality of Fano and together they are currently managing the Landfill of Monteschiantello, in the northern part of the Region (Pesaro and Urbino Province). The latter is classified as a municipal solid waste landfill (MSWLF) and receives non-hazardous waste.

As a public utilities company in the Province, ASET is the also responsible for the waste management services of 12 municipalities whose household waste are pre-treated and disposed of at Monteschiantello.

Figure 1. The Landfill of Monteschiantello on the map. Source: Studio Agronomico Agriante, April 2011, Environmental Remediation Plan Review - Executive Project

Figure 1 indicates the position of the landfill on the map in Fano (Central Italy), while Figure 2 shows an aerial photo of the dumpsite.

Figure 2. Aerial photo of the Landfill of Monteschiantello. Source: ASET Spa,2021

The Landfill of Monteschiantello was built in an old quarry traditionally used for the extraction of clay. Thanks to the valley natural slopes, the dumpsite was built by excavating and creating a soil embankment where the waste was stored and buried, in line with the common methods of waste disposal.

The landfill site is currently formed by two adjacent basins. The first one is called "**Basin 1**" and is situated in the North-eastern part of the area where the old municipal dumpsite was operating from 1978 to 1996. Now, Basin 1 is completely rehabilitated. Basins 2 was built after the first one and was activated in 1996 and it's still working today.

The old Monteschiantello dumps can be considered as an open dump even though, since its beginning, some technical and management measures have been put in place, such as the area delimitation, the excavation of storage tanks up to the clay layer, the placement of bottom drainage for leachate collection, the regimentation of rainwater, the daily covering with soil, and the recording of incoming waste in terms of quantity and quality.

Thanks to the proximity to the operational landfill site and the financial resources given by the municipality of Fano, Basin 1 underwent several improvements which ended in its rehabilitation. The present Italian case study provides the guidelines that can be relevant for the rehabilitation of similar dumpsites.

2. Geomorphologic and hydrogeological characteristics of the site

From a geomorphologic point of view, the area in which the Landfill is located is hilly and slightly undulated, in an altitude range that rarely exceeds 150 m. As in clay *lithofacies*, its sides range from slightly to moderately steep slopes. In some cases - where the arenaceous-pelitic associations become prevalent - the landscape assumes more marked characteristics, with the presence of local slopes more acclivity delimited by steep escarpments, created by erosive and/or structural phenomena.

From the geological point of view, the area originated in the Pliocene and consists of a succession of clay, marly clays and sandy-siltose marly clays with slight intercalations of pelitic-arenaceous and arenaceous-peltics units at different heights. The whole sequence has a few hundred meters of thickness and indicates the phase of marine transgression and the beginning of the regressive phase characterized by the decrease in depth of the sedimentary basin. The average direction and immersion of geological strata shows a general stability of the site whose tectonics does not have structures such as faults or folds, nor other important elements.

From the hydrogeological point of view, the strata consisting mainly of receding lithological classes such as silty-clay and clay-marly, can be considered impermeable [permeability coefficients K in the order of 10^{-8} cm/sec]. Moreover, the penetration of meteoric water is inhibited by the pelitic origins of the area which prevent the formation of aquifers and cause surface runoff phenomena instead, such as micro-water streams, surface erosion and soil flows.

Rainwater infiltrations and runoff only occur when the thickness of the sandy levels inside the colluvial and alluvial layers increases, fostering the creation of small suspended aquifers, which are mainly linked to seasonal weather patterns. On the other hand, whenever the sandy layer is blocked by impermeable clay lithofacies, the aforementioned aquifers become small sources of water for the different ditches around the landfill area.

The hydrogeology of the area is differentiated according to the lithologies present. Proceeding downward, we find the Pliocene formation, preceded by its altered summit, characterized by marly clays of grey-blue chromatism with extremely low coefficient of permeability K, less than $1x10^{-9}$ cm/sec, which also serves as a aquifer for the nearby floodplain of the Metauro River.

3. From open dump to landfill

Since the 70s, professional geologists and environmental scholars working for the municipality of Fano had used the Monteschiantello area for the disposal of urban waste (in some cases, other types of waste also) thanks to its position on the edge of the territory. The economy of the area was largely characterized by a mostly rural lifestyle and the problem of how to dispose of waste was certainly still marginal.

As previously said, the site was used as a quarry for the production of clay-bricks for the construction industry. Due to their renowned low permeability, clay outcrops offered enough protection from the potential damages of waste pollution which were almost unknown at the time. For these reasons, the old dump of Monteschiantello worked as a storage for urban waste which was unloaded, conveniently spread and then buried. Moreover, a basic but precious bottom drainage system was created for collecting the leachate in an existing basin. Down the valley, a soil embankment was created to increase the disposal capacity of old dumpsite.

Later, in 1986 the landfill expansion project suggesting the creation of a second basin was drawn up to comply with one of the first Italian regulations concerning waste management, namely the Presidential Decree n. 915/82 "*Implementation of Directive (ECC) n. 75/442 on waste".*
In particular, the new landfill project included:

- instructions for the collection of leachate directly to the municipal treatment plant;
- the future implementation of a basic capping system at the end of the landfill life cycle consisting of a clay layer (50-100 cm) and final vegetative soil (20-30 cm); the goals was the landfill site rehabilitation and renaturation.

All these mandates were effectively carried out at the end of the old landfill disposal capacity.

Geoelectric and geometric surveys on the area showed that Basin 1 received over 1'500'000 tons of different urban and industrial wastes produced by human activities of the territory. The following is an aerial photo of the Monteschiantello landfill back in 1996

Figure 3. The landfill of Monteschiantello (Basin 1 circled in red). Source: ASET Spa, 1996.

With Legislative Decree n. 36/2003 – *Implementation of Directive 1999/31/EC on the landfill waste*, specific regulations for landfills were established. In 2004 the municipality of Fano and ASET promptly submitted an **Adjustment Plan** for the Monteschiantello landfill thanks to the economic incentives offered by the government at the time.

The adjustment plan called for the environmental recovery of the Basin 1 through:

- the creation of a new capping system consisting of (Fig. 2.2, from bottom to top):
  - a levelling later;
  - a compacted clay layer (at least 50 cm) acting as impermeable mineral layer;
  - a geocomposite layer as drainage for surface waters;
  - a vegetative soil layer (at least 30 cm) for planting indigenous and resistant plant species;
- the creation of a collection network of meteoric waters (Figure 4) flowing into a new basin to be used for irrigation;
- the creation of an underground drainage trench surrounding Basin 1 (Figure 5) to collect potential leachate residues on its edges, thus preventing seepage.

These operations aimed at limiting the infiltration of rainwater into the waste body, minimizing leachate production and optimizing the collection and treatment capacity of the landfill unit.

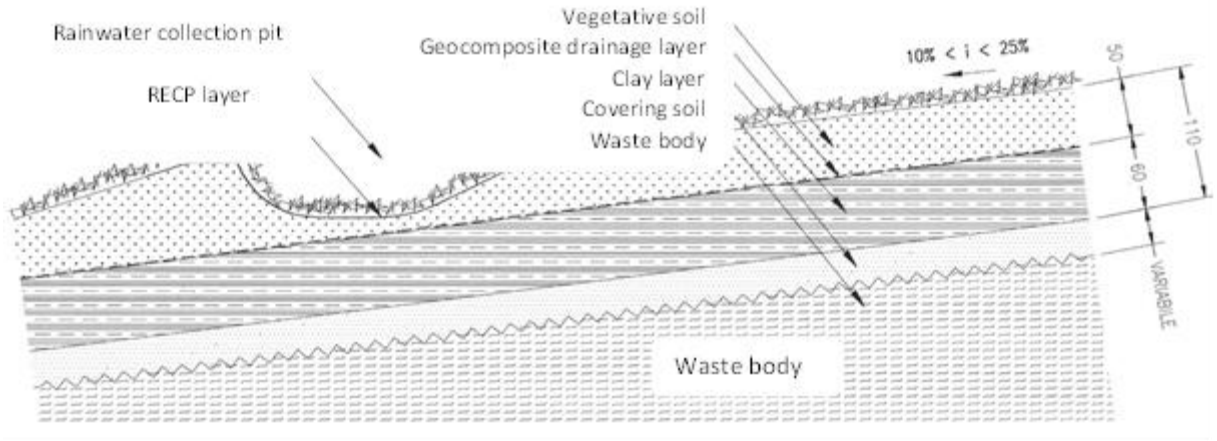

Figure 4. The capping system of Basin 1 – Stratigraphy- Source: Donini A., Pelonghini L., ed. 1998,2004, Geological-geotechnical reports carried out on the occasion of the projects for the construction of the leachate lagoon and the reservoir lake.

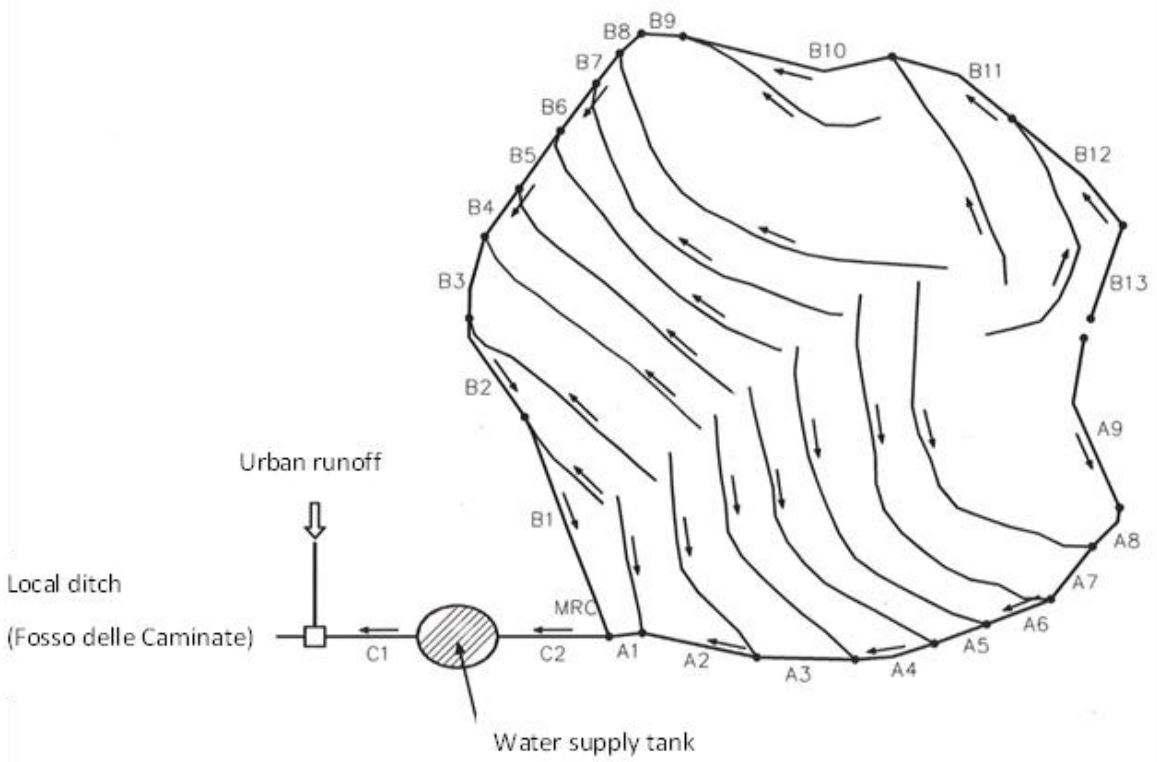

Figure 5. Collection network of meteoric water - Basin 1. Source: Donini A., Pelonghini L., ed. 1998,2004, Geological-geotechnical reports carried out on the occasion of the projects for the construction of the leachate lagoon and the reservoir lake

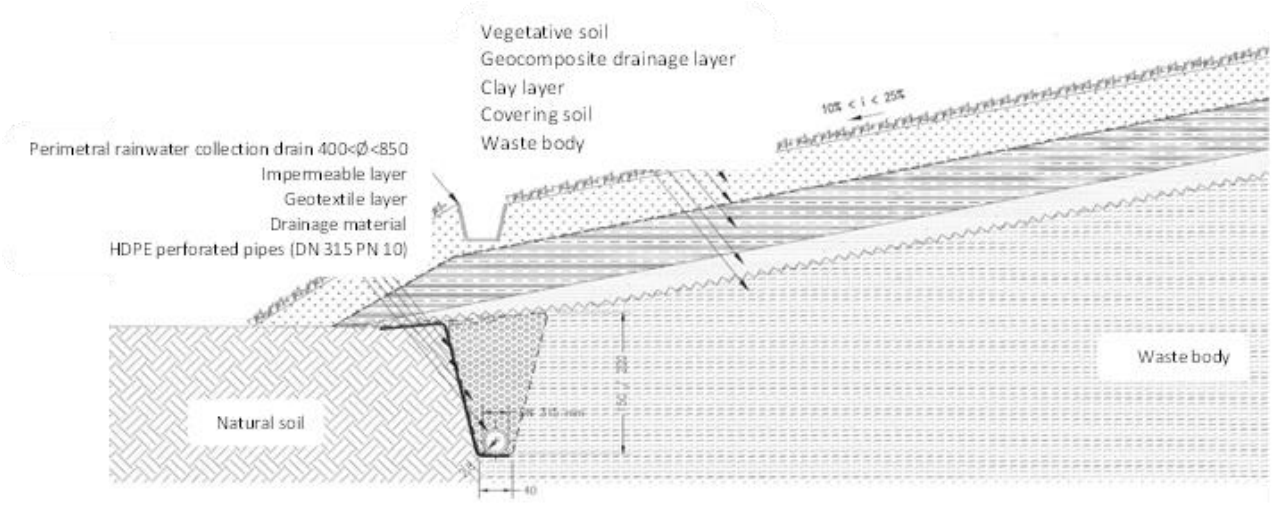

Figure 6. Drainage trench surrounding Basin 1- detail. Source: Donini A., Pelonghini L., ed. 1998,2004, Geological-geotechnical reports carried out on the occasion of the projects for the construction of the leachate lagoon and the reservoir lake.

Furthermore, in the same project focused on the construction of a **biogas extraction plant** able to produce energy through an endothermic engine plant. Its main components were:

- collection wells covering all the Basin 1 area which are drilled on the waste body at the bottom of the tank (Figure 7 – see the radius of influence);

- secondary lines connecting the extractions wells with the regulating stations surrounding Basin 1; they have connecting and dosing functions for the extraction station;
- a central station for biogas collecting, cooling and compression;
- an endothermic engine equipped with an afterburner for exhausted gases;
- an emergency torch or combustion of biogas during engine downtime due to failure or maintenance.

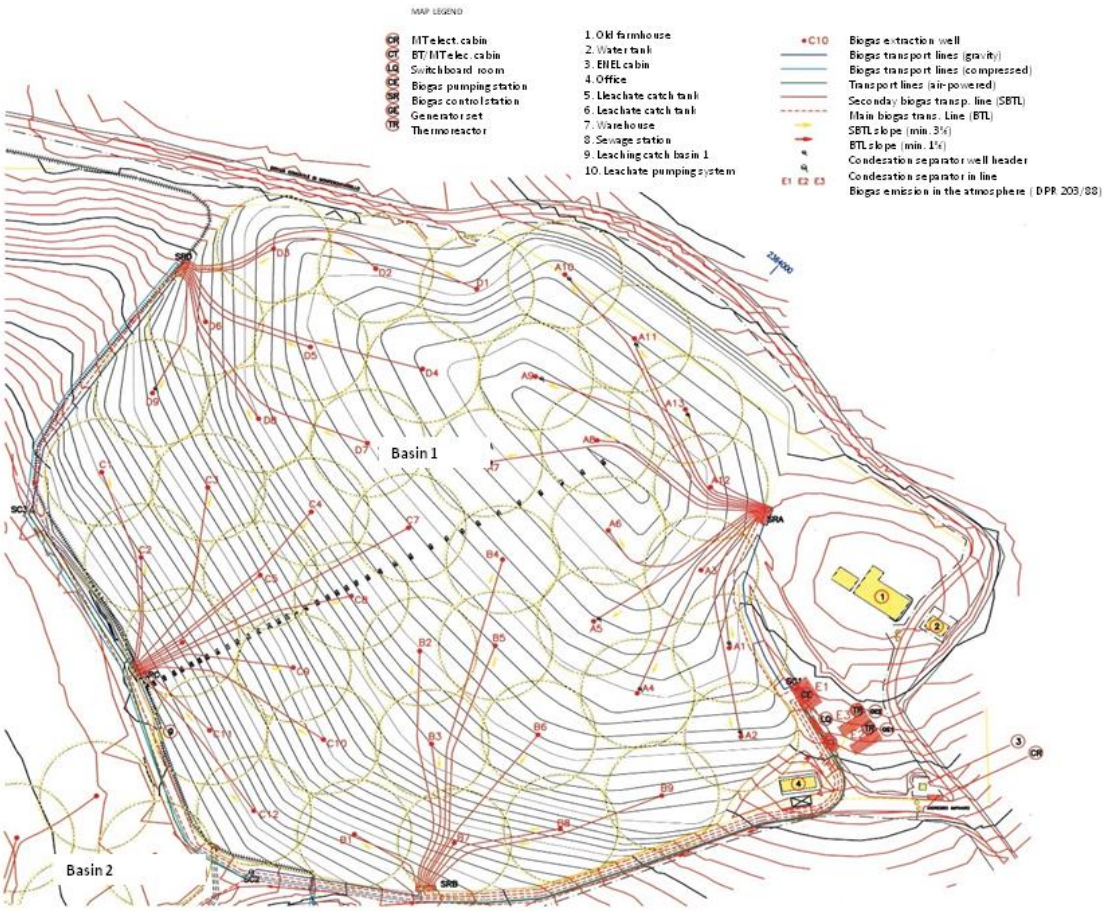

Figure 7. Biogas extraction wells and collection systems – scheme. Source: ASWS International, May 2003, Final Environmental Recovery Project - Biogas Capture and Combustion Facility with Energy Recovery Basin1.

The biogas extraction wells are particularly interesting and useful because they work both as a leachate drainage system – thanks to the collection ring made of basalt gravel - and as biogas collection system connected to the regulating stations, and then to the central station (Figure 8).

The biogas extraction system was adapted to Basin 1 needs considering that its biogas production of was gradually decreasing. New extraction wells were gradually built on the area, along the landfill expansion process.

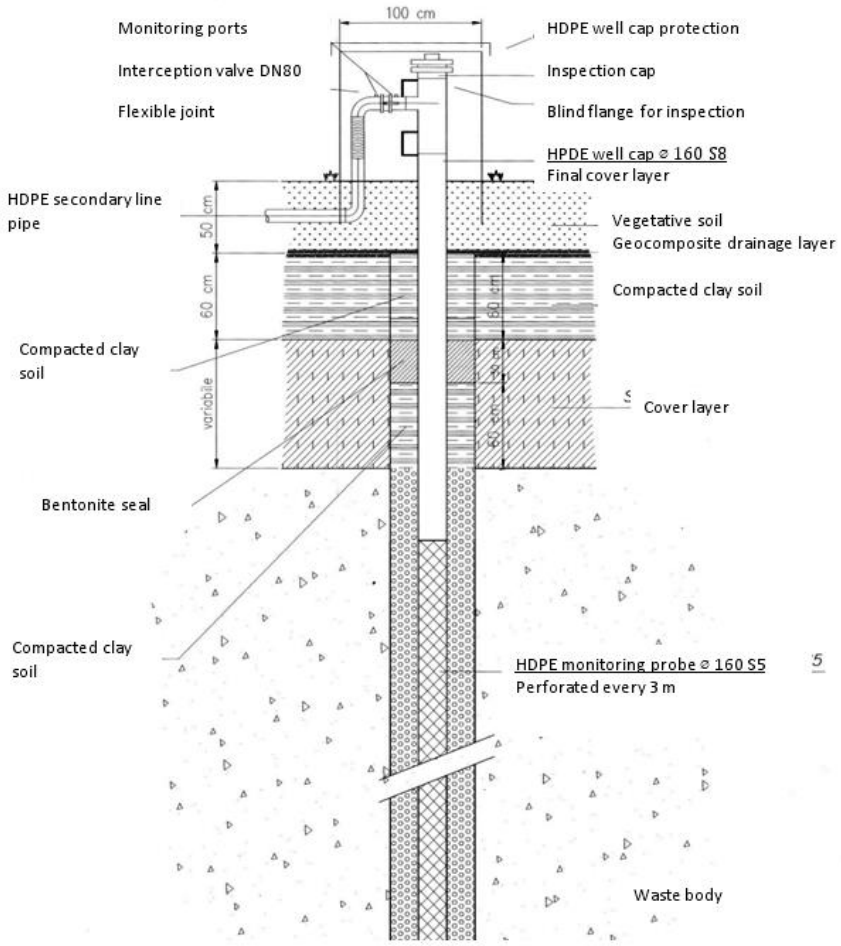

Figure 8. Biogas extraction tube drilled into Basin 1- detail. Source: ASWS International, May 2003, Final Environmental Recovery Project - Biogas Capture and Combustion Facility with Energy Recovery Basin

4. The environmental restoration plan

After achieving the 2004 Adjustment Plan and in line with the evidence of the Monitoring and Control Plan (see section 4- Monitoring), further reinforcements of the existing systems were carried out in Basin 1. Among the improvements put in place, the **Environmental restoration plan** deserves attention. Its main goal was improving the overall quality of the *landfill ecosystem* fostering its integration in the territory from the environmental, ecological and landscape point of view. Consequently, to rehabilitate the site, it was pivotal to ensure the landfill integration in the

landscape as much as possible during the operational management phase and at the end of its life cycle. For example, the visual impact had to be improved by hiding the biogas extraction wells by appropriate plant arrangements in the area.
The renaturation of the landfill site was thus strictly linked to the environmental context of the Monteschiantello area and its indigenous flora growing on the vegetative soil. This required a careful preliminary study of the morphology of the landfill site (e.g., slopes exposure), of its climate conditions (e.g., proximity to the sea), and of its soil characteristics. Other factors such the different soil thickness and the potential phytotoxic effects of biogas leaks were taken into consideration.

The planting of different species of native tree and shrubs also allowed to reinforce the local environment in terms of quantity and quality creating a good habitat for birds. This is due to the vastness of the area (8 hectares) which is fenced from farming, people and wild animals. In fact, since a few years the periodic cutting of the grass is scheduled after the nesting period of the birds present. Choosing to sown meadows and to grow thousands of native plants favouring non-weed species, while vegetation diversity ensured the ecological stability in extreme weather events.
While shrubs (e.g., *plum, wild rose, hawthorn, broom, phillyrea, etc.)*, were planted on the waste area, different trees species (*holm oak, cypress pine, tamarisk, elm, black locust, etc*.) were planted along the perimeter and outside the waste area.

The images below compare the initial and final situation of the Landfill of Monteschiantello (Figure 10 and 11).

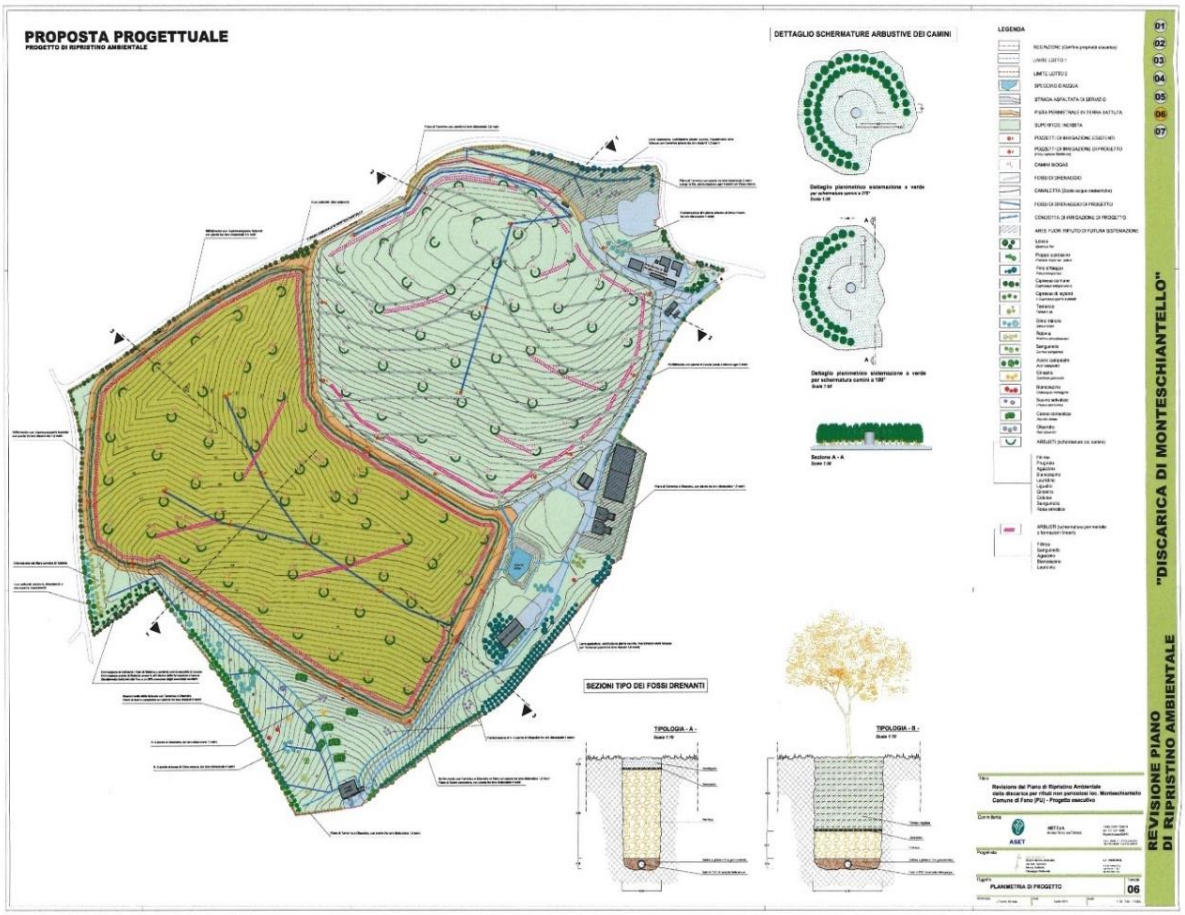

Figure 9. Environmental restoration plan- scheme. Source: Studio Agronomico Agriante, April 2011, Environmental Remediation Plan Review - Executive Project.

Figure 10. Basin 1 – Initial stages of the landfill Environmental restoration plan. Source: ASET Spa,2003.

Figure 11. Basin 1- Final stage of the Environmental restoration plan. Source: ASET Spa, 2011.

5. Monitoring

After achieving its full rehabilitation and renaturation, the monitoring activities of Basin 1 fall under the scope of the **Monitoring and Control Plan** of the operating landfill, as established by Legislative Decree n. 36/2003 and amendments. In particular, there are specific monitoring activities which are scheduled- shown here in brackets- and concern:

- Air quality analysis (semi-annual);
- Biogas leakage measurements (annual);
- Groundwater analysis with samples taken from piezometers situated along a specific area; surface runoff water analysis (every 3 months);
- Quantity and quality leachate analysis (every 3 months);
- Monitoring of piezometric levels, even inside some biogas extraction wells (every 3 months);
- Morphological control by topographic and settlements survey according to (annual);
- Soil quality analysis by geoelectric surveys based on fixed transects to detect potential leachate seepage or biogas leakage (annual).

The activity described allows to collect many environmental data that allow to intervene where possible problems are identified; in some cases (as for the north side) have been built additional wells and trenches drainage, in order to contain possible external leachate contamination.

6. Rehabilitation

The final aim of a landfill is its rehabilitation and integration in the territory in the best possible conditions. This is possible thanks to an effective and efficient landscape and monitoring plan aimed at controlling the landfill impacts on the environment which, as previously saw, can last for years. The dumpsite concealment can only be misleading and dangerous, causing irreparable damage to the environment.

Most of the times, what is invisible in a landfill is more harmful that what is in plain sight if not properly managed. As Saint-Exupèry wrote "*The essential is invisible to the eyes*".
Landfill sites usually occupy large areas that can be reused for industrial or leisure purposes, if needed.

As shown in this case study, considerable efforts were made to rehabilitate the old Monteschiantello dump, particularly Basin 1, and managers thought about the possibility of giving

it back to the community also because of its panoramic view. Unfortunately, the proximity to the operational landfill can still compromise its fruition somehow.

At the moment, the benefit of this part of the landfill is three-sided. Aside from the environmental function previously described, the site has also educational purposes for visiting schools and other groups interested in the waste life cycle. Furthermore, the municipality of Fano and ASET are considering the idea of installing, in the upper part of the landfill site, a solar power plant for the supply of electricity.

7. Conclusion

This case study presented the steps behind the rehabilitation of an urban waste landfill located in the municipality of Fano (Italy) which operated from 1978 to 1986. Historical sources confirmed that the site, at the beginning of its life cycle, can be now classified as an *open dump*, as the waste collected wasn't monitored nor controlled in any way. However, the non-random choice of the disposal site and some of the measures introduced by former managers, have shown an increasing environmental sensitivity.

Gradually, landfill regulations are becoming stricter both on national and European level leading to the implementation of different enhancements which also concerned the Landfill of Monteschiantello. Nowadays, professional landfill managers and technicians have a good level of knowledge of the potential environmental impacts of the landfill and carefully follow the Monitoring and Control Plan. The goal is understanding and mitigating every phenomenon in case of pollution of the surrounding area.
The renaturation process recently carried out has successfully integrated the landfill site in the context at naturalistic and landscape level.

It should be noted that these improvements were possible thanks to proximity to the operational landfill which, together with the old dumpsite (administratively closed), had to comply with the landfill regulations that gradually came into force.

From the economic point of view, the financial resources deriving from the management of the operating landfill allowed the allocation of part of the money to the improvements, covering both investments and the maintenance costs. Last but not least, the control authorities often focused more on improving the existing plant rather than on its expansion. The old open dump benefited

from the aforementioned choices together with the environment and the community living in the territory.

References

Donini A., Pelonghini L., ed. 1998,2004, *Geological-geotechnical reports carried out on the occasion of the projects for the construction of the leachate lagoon and the reservoir lake. (Relazioni geologico-geotecniche eseguite in occasione dei progetti per la realizzazione della vasca per il lagunaggio del percolato e del lago di riserva idrica)*

*A*SWS International, Montana Srl, May 2003, *Final Environmental Recovery Project - Biogas Capture and Combustion Facility with Energy Recovery Basin 1. (Progetto Definitivo di Recupero Ambientale – Impianto di captazione e combustione biogas con recupero energetico Bacino 1)*

Studio Agronomico Agriante, April 2011, *Environmental Remediation Plan Review - Executive Project. (Revisione del Piano di Ripristino Ambientale – Progetto Esecutivo*)