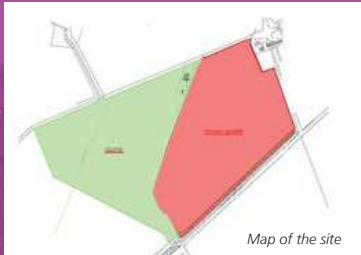


Anaerobic and aerobic biobarrier for the groundwater management of a former industrial landfill in Italy

G. Buscone, L. Ledda, L. Ferrari (Tauw Italia)

Site description

- Former landfill filled with industrial wastes (tars, sludges, chalks, ashes, etc.)
- Leaking of contaminants into groundwater over the years had generated a plume of 17ha
- High concentrations (up to 500.000 µg/l) of different contaminants (see table below)
- Hydraulic containment in place, with high costs and low efficiency in the removal of contaminants



	Limits	Upstream plume C (µg/l)	Downstream plume C (µg/l)
CoC	200	20500	4100
Iron	50	900	120
Manganese	0.5	300000	21200
VC	810	9300	9900
1,1 DCA	3	10500	5100
1,2 DCA	0.05	62000	340
1,1 DCE	60	25600	2700
1,2 DCE	0.2	83000	3
1,1,2 TCA	1.5	17200	250
TCE	1.1	2900	7
PCE	1	300	170
Benzene	350	8000	1200
TPH			

Remediation strategy

In situ biodegradation in order to replace the existing hydraulic containment, as all the contaminants are bio degradable (some anaerobically and others aerobically). The system consists of biobarriers:

- Anaerobic barrier: located along the landfill border to degrade main contaminants (Chlorinated ethenes and ethanes) through the injection of an electron donor (organic substrate)
- Aerobic barrier: located downstream to degrade the rest of contaminants (MCB, TPH, BTEX, etc.) through the injection of oxygen (compressed air) and nutrients (N,P)
- Possible additional biobarrier, depending on the effectiveness of the whole system

Expected Goals:

- High efficiency of anaerobic biodegradation at the landfill border
- Concentration of all contaminants close to law target limits at the site border
- After reaching of the above goals, shut off of the hydraulic containment system



Remediation conceptual layout

Tests

Lab test

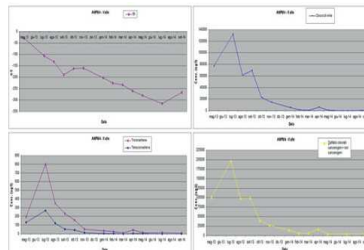
- Successful anaerobic biodegradation of Chlorinated ethenes and ethanes by adding organic substrate in groundwater samples from the site
- Successful aerobic biodegradation of BTEX, TPH, Chlorobenzenes, 1,2 DCE and VC, by shifting the process from anaerobic to aerobic, adding O₂,N,P.

Field pilot test

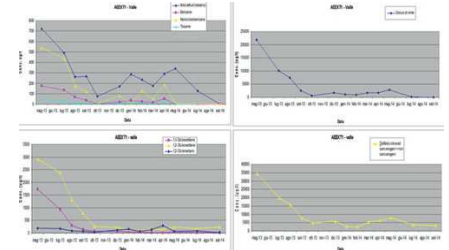
Two pilot areas, consisting in one small anaerobic biobarrier at the landfill border and in one small aerobic biobarrier at the site border, were installed and operated at the site in 2013-2014.

Test results showed a quick establishment of right process redox conditions and a consistent decreasing of concentration of all main contaminants in both anaerobic and aerobic pilots:

Anaerobic pilot results



Aerobic pilot results



Full scale design

Full scale remediation design (Phase 1) approved by Public Authorities in 2015, consisting of:

Anaerobic biobarrier:

- 420 m total length
- 21 extraction wells
- 22 injection wells
- 14 monitoring wells (7 upstream and 7 downstream)
- 3 substrate dosing units

Aerobic biobarrier:

- 500 m total length
- 21 extraction wells
- 39 injection wells
- 46 air sparging wells
- 11 monitoring wells (5 upstream and 6 downstream)
- 3 compressed air and nutrients dosing units

Operation and monitoring

- Remediation started on July 2016, full efficiency of Phase 1 is expected within two years
- Two-monthly groundwater monitoring (upstream and downstream)
- Results after one year of remediation:
 - Good results in the anaerobic biobarrier (high efficiency of degradation process)
 - Efficiency of aerobic biobarrier must be improved by increasing air/oxygen injection

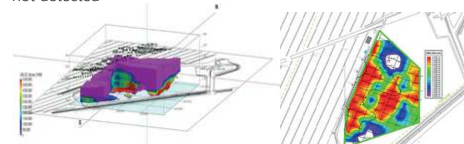
Researches

A cooperation with the Department of Environmental Biology of the University of Milan was established for the biological monitoring of the process. Biological analyses are carried out in parallel to the chemical analyses, in order to monitor the progress of the biological process.

Detailed investigation

Membrane Interface Probe (MIP) detailed investigation was performed into the landfill to delineate contamination and detect DNAPL, by means of n. 70 vertical MIP until 10 m b.g.l.

Outcome: Detected very high concentration of contaminants, DNAPL not detected



MIP DELCD response (landfill 3D)

MIP DELCD response (layer at the bottom of the landfill)

Next steps:

layout completion

Installation of a second anaerobic biobarrier at the landfill border (Phase 2), upstream of the existing anaerobic biobarrier (feasibility under investigation and assessment).

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