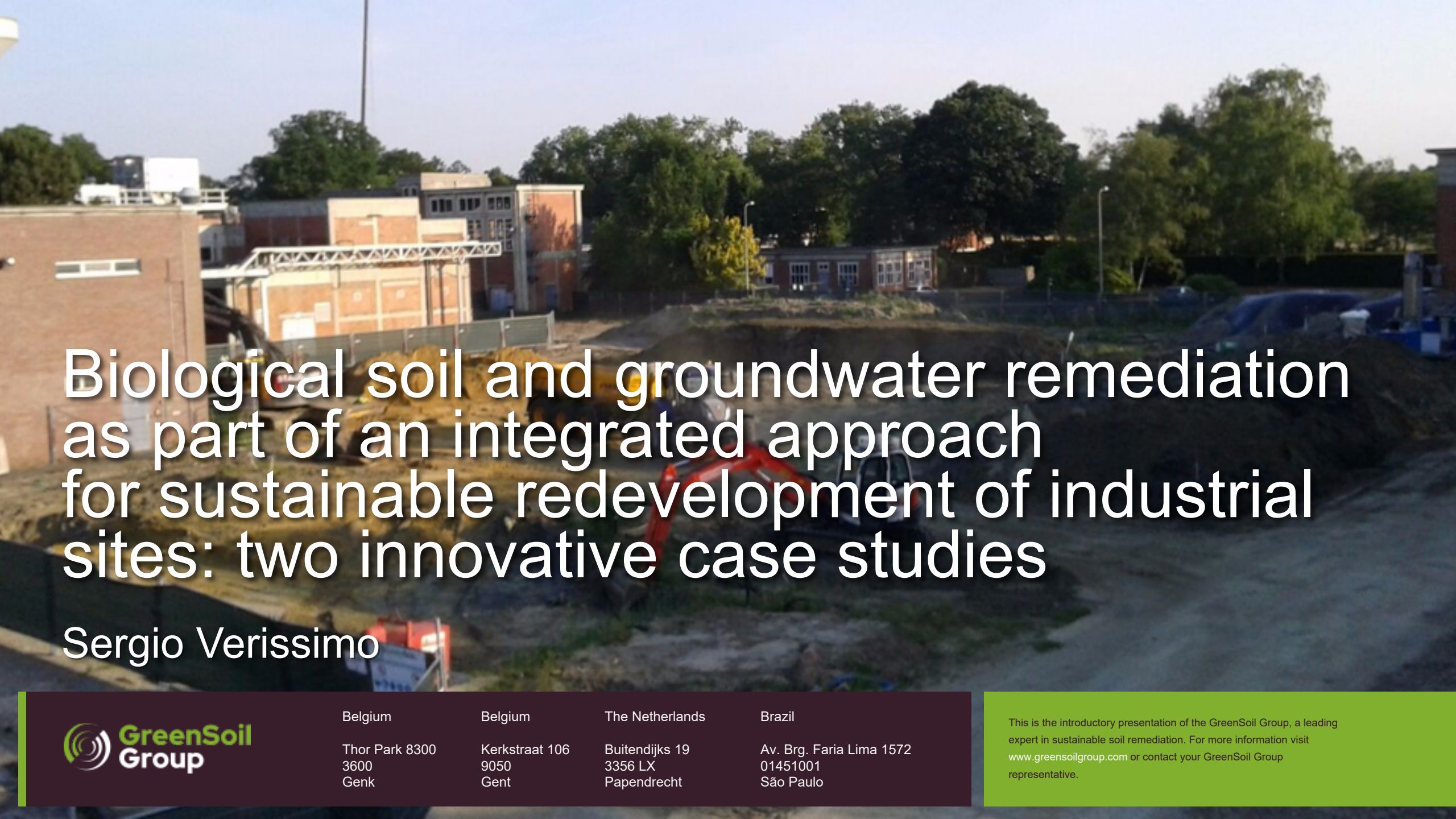

Biological soil and groundwater remediation as part of an integrated approach for sustainable redevelopment of industrial sites: two innovative case studies

Sergio Verissimo

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This is the introductory presentation of the GreenSoil Group, a leading expert in sustainable soil remediation. For more information visit www.greensoilgroup.com or contact your GreenSoil Group representative.

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Sérgio Veríssimo

CEO GreenSoil do Brasil

Improving the health of our soils in a sustainable way is crucial for a better environment in low CO2 print world.

We are the GreenSoil Group

The GreenSoil Group is a leading expert in sustainable soil remediation. We design and deploy tailormade solutions to biologically clean the soil and groundwater and decontaminate even the most challenging sites all around the world.

We do this with the highest degree of reliability and accountability to meet both regulatory and aspirational safety & sustainability standards.

10+
CONTAMINANT TYPES

12+
COUNTRIES

15+
YEARS OF EXPERIENCE

>1.5 mln
m^3 TREATED

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Bioremediation and sustainable redevelopment – why do they go together?

The overall objective is to remove the contamination and give back the original value to the soil and groundwater by minimizing waste production and carbon footprint.

Sustainable Redevelopment

- Avoid creating or moving waste from A>B
- Remove contaminant mass efficiently
- Use nature-based process (no chemical,…)
- Minimize energy consumption
- Maxima Re-Use of natural resources

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Bioremediation with Sustainable Redevelopment

On-site remediation	Contaminant removal	Circular use of materials	Integrated design	Cost-effective
• Risk reduction for subsequent redevelopment • Limit Soil and Chemical transport	• Removal or degradation of contaminant • Long-term vision	• Reduce waste • Limit transport emissions	• Combine remediation with redevelopment	• Sustainable and on-site treatments • Integration saves time & $$

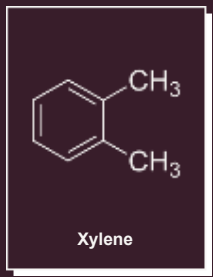
Case study #1

Sustainable Cyclic Remediation of a Heavily Impacted Site with Xylene

A former triacetate production site caused a heavy xylene contamination up to 27,850 mg/kg in soil and 89,000 µg/l in groundwater, to a depth of 10 m-bgl.

On-site and in-situ biological remedial approach were proposed to remediate soil, groundwater and soil vapor heavily impacted with BTEX, mainly Xylene.

Contamination type:	**BTEX**
Approach:	**Aerobic on-site and in-situ**
Contract type:	**Risk based**
Period:	**2017 - 2019**
Contract value:	**1,500 – 2,000 k€**



Xylene

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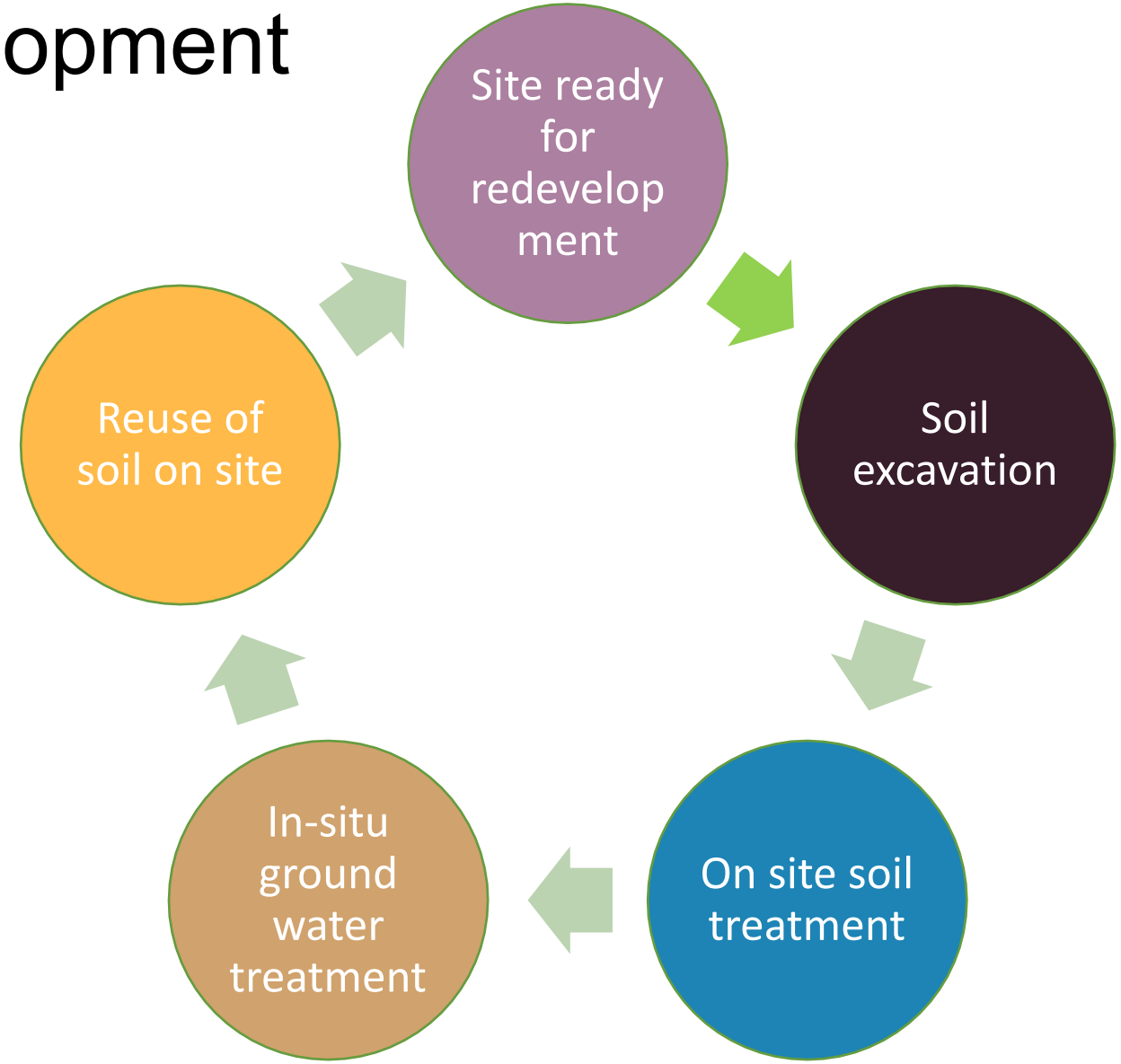
Path to redevelopment



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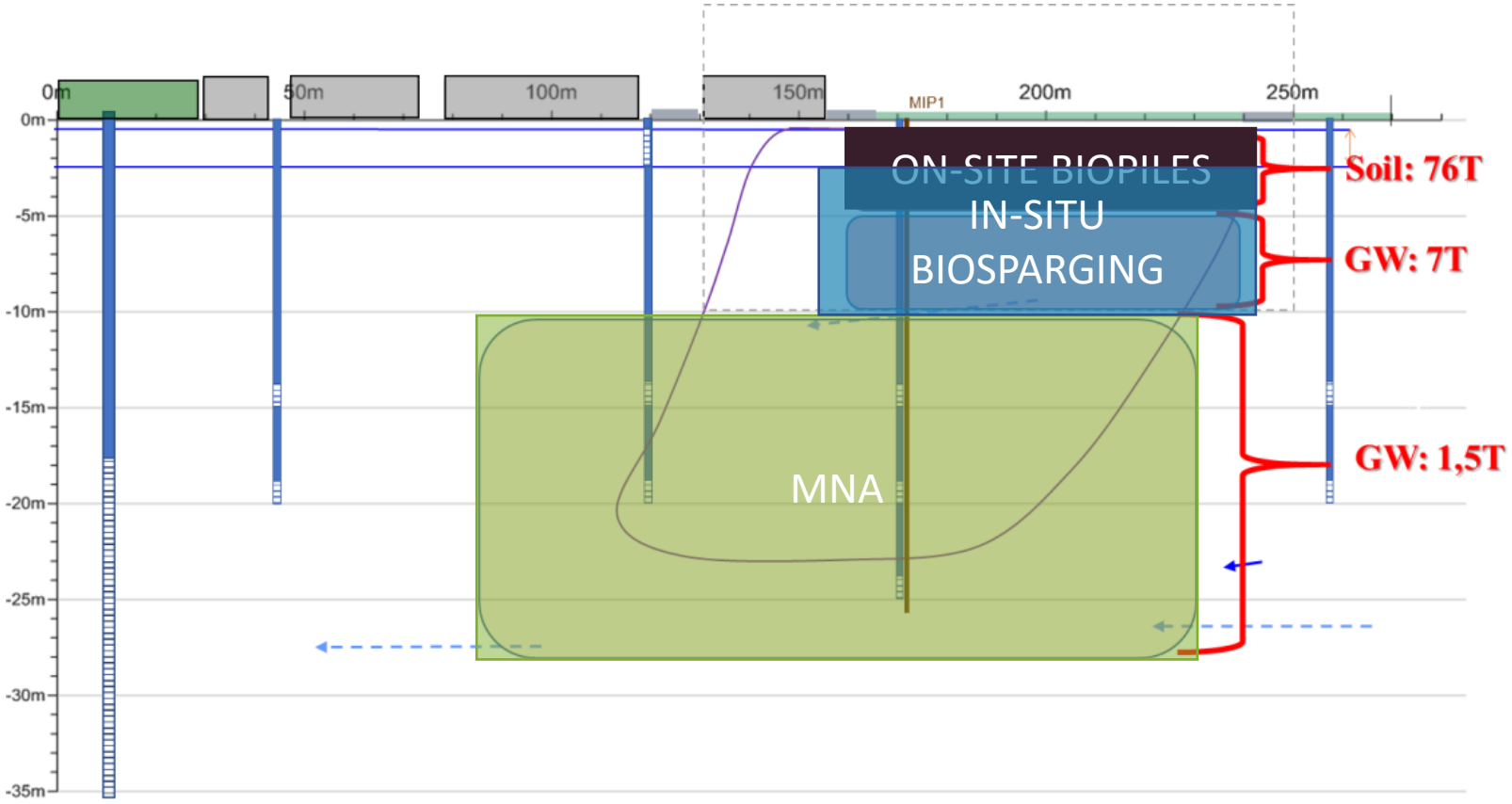
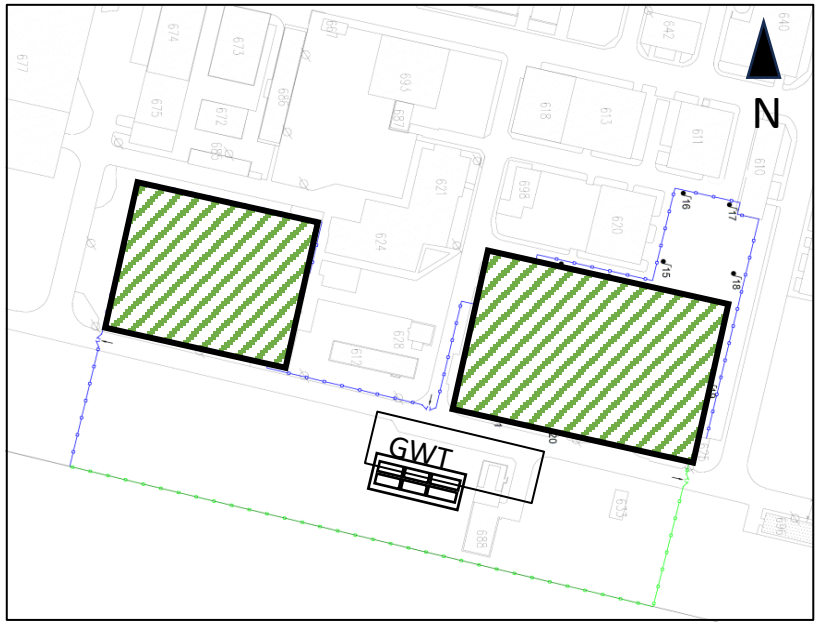
Site Conceptual Model





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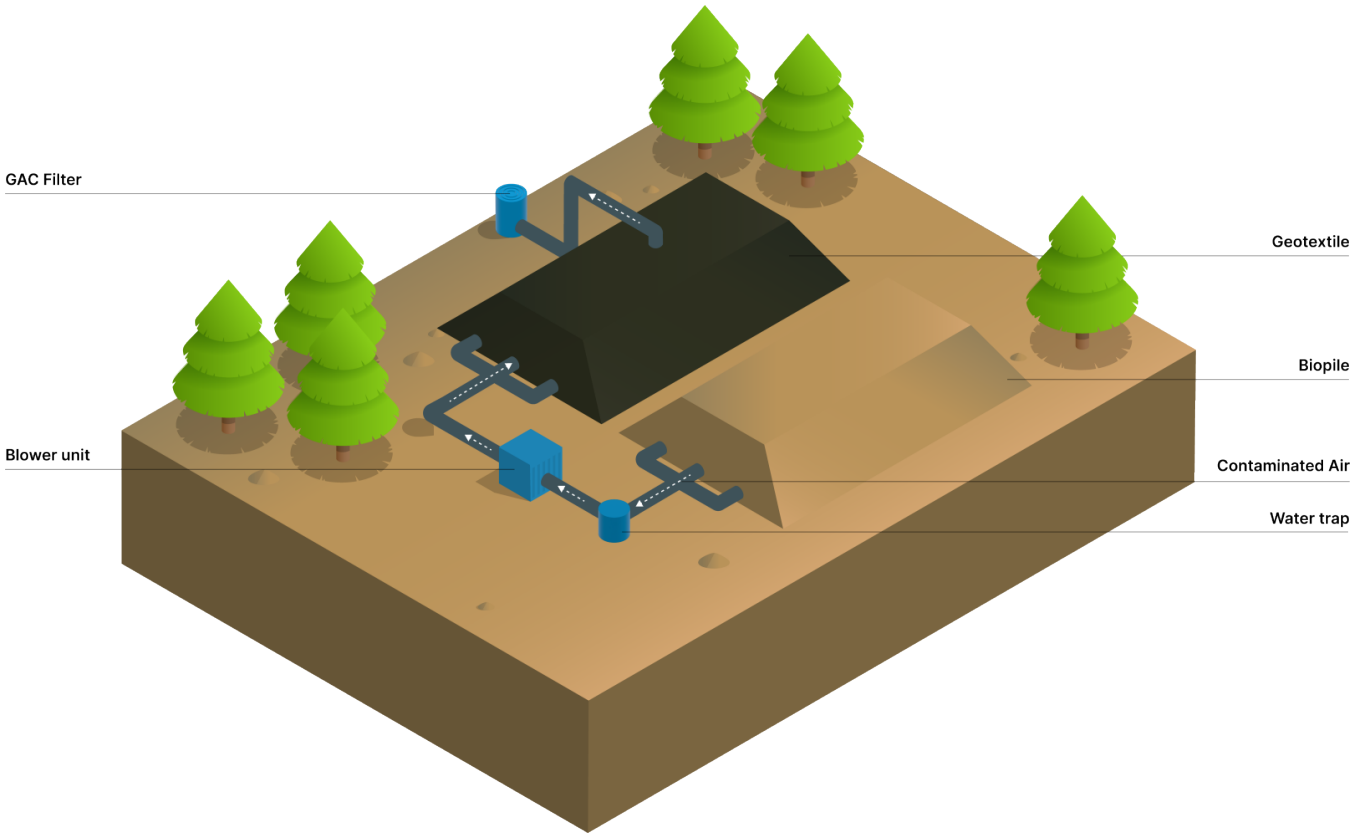
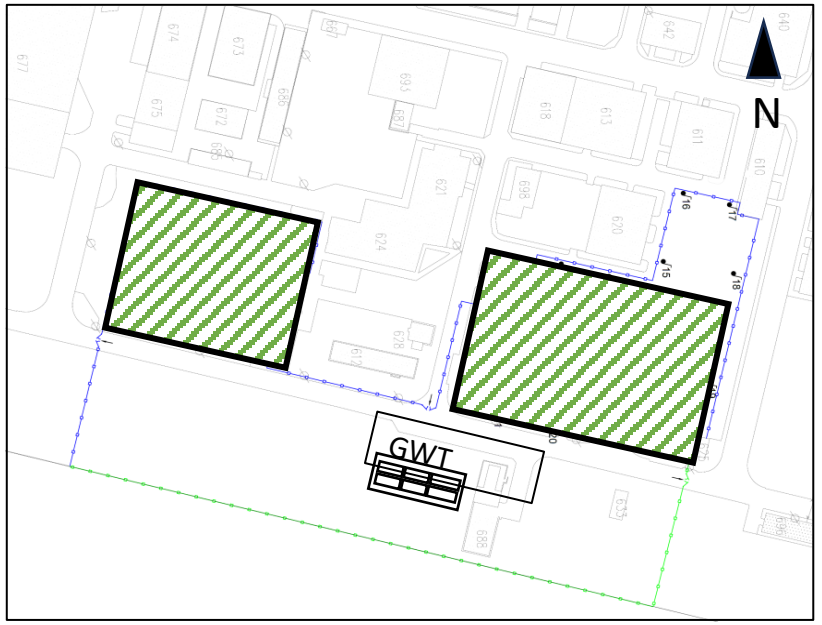
On-site soil treatment process (biopiles)





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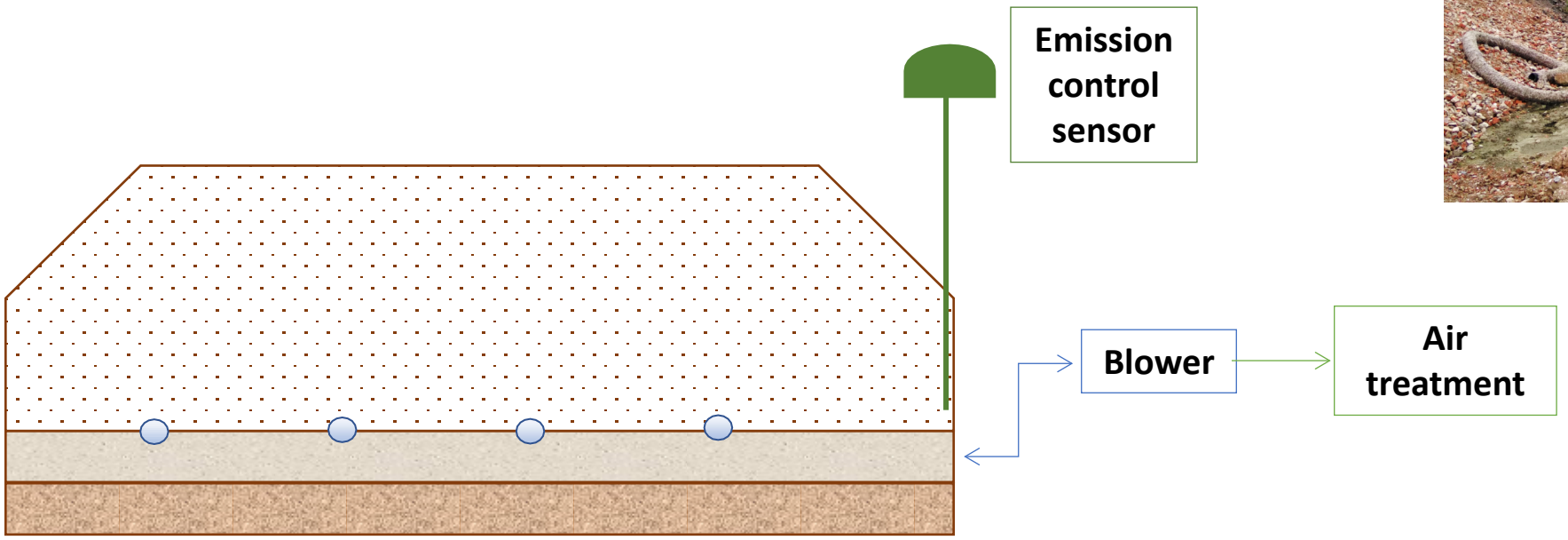

Site works

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On site soil treatment process (biopiles)

Stage 1
Lowering of the groundwater level
→ GWT

Stage 2
Excavation and biopile construction within the source area
→ Limit nuisances (e.g., transports and air emissions)

Stage 3
Stimulation of biodegradation of contaminants in soil, water and air

Stage 4
Leveling and reinstate soils

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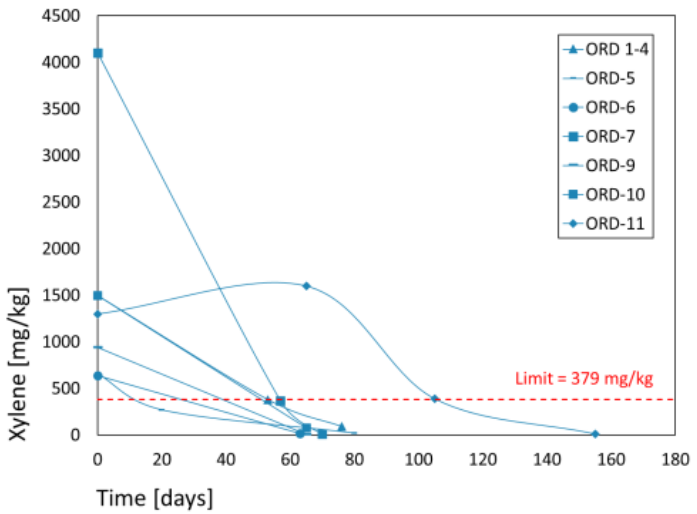
Remediation Results

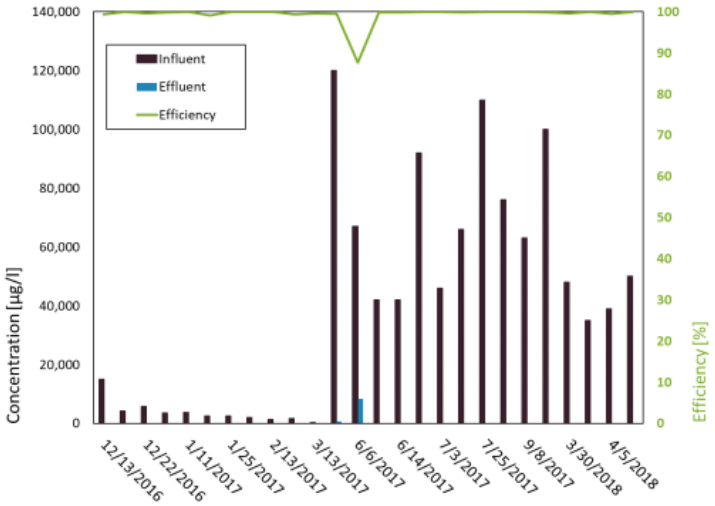
Soil

Biopiles were cleaned within 70 days ≥ 25,000 m^3 of contaminated soil treated to levels << remedial target within **18 months**.



Groundwater

The GWT was highly efficient (>99%), removing the bulk of the incoming groundwater mass in combination with a conventional polishing step.



Soil vapor

Highly concentrated soil vapors (up to 8,000 ppm) were treated biologically by the BAT with a removal efficiency up to 80%.

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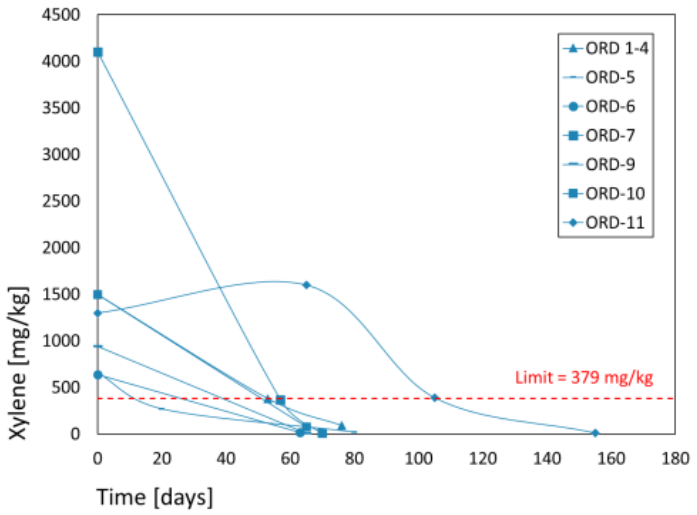
Soil & water Results

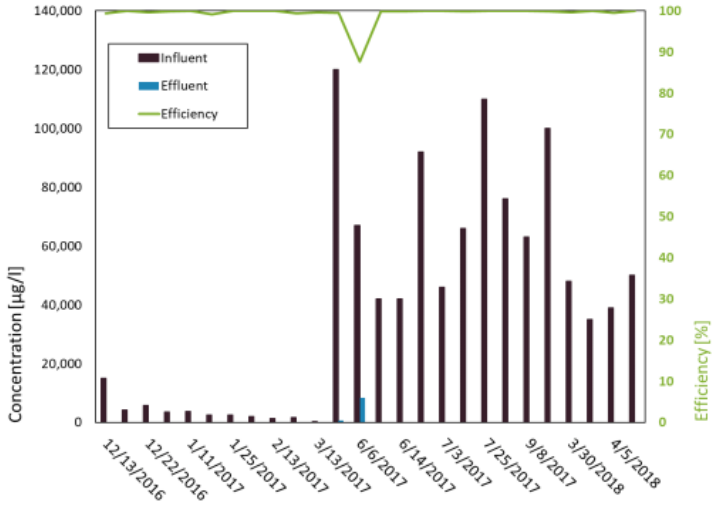
Soil

Groundwater

Soil vapor

95-100 tons of contamination (waste) degraded and 100% of soil (resource) regenerated





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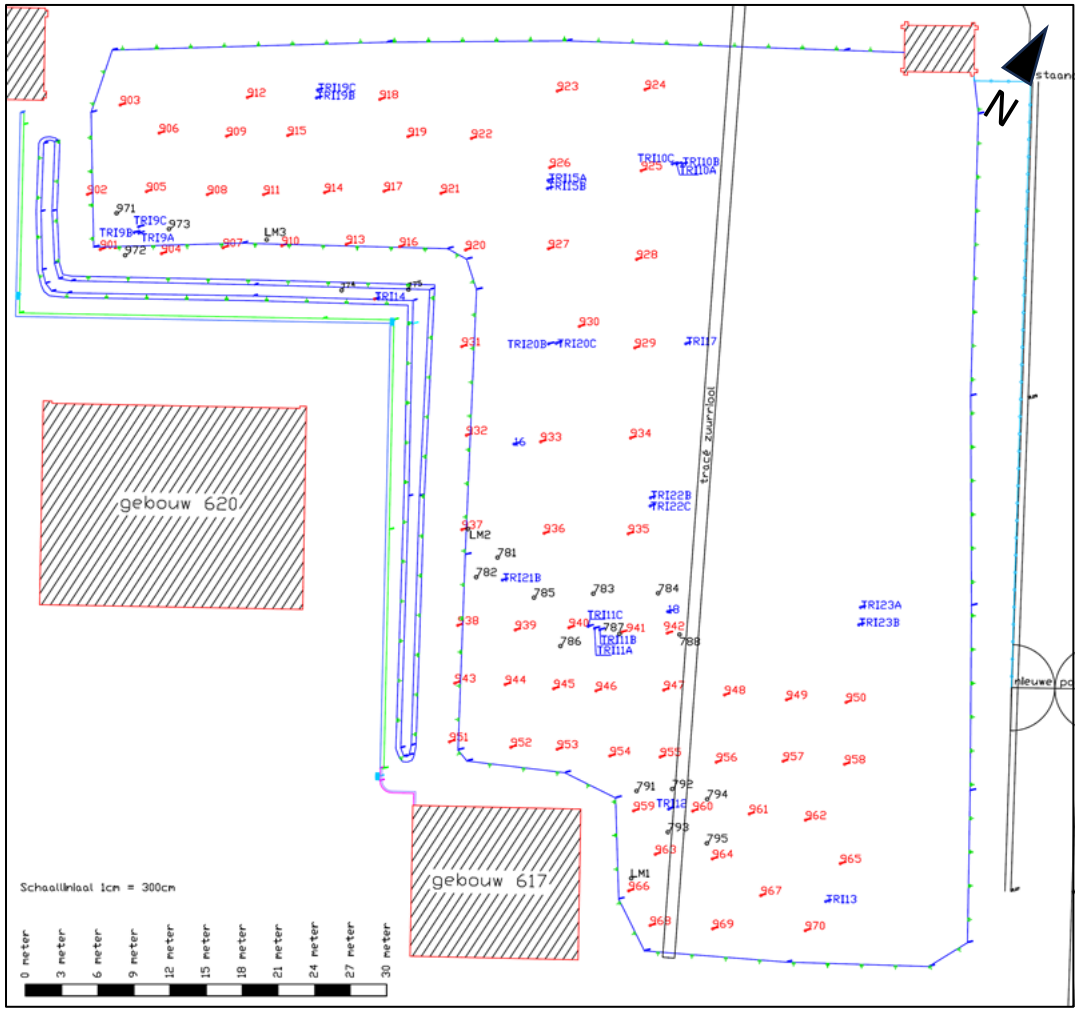
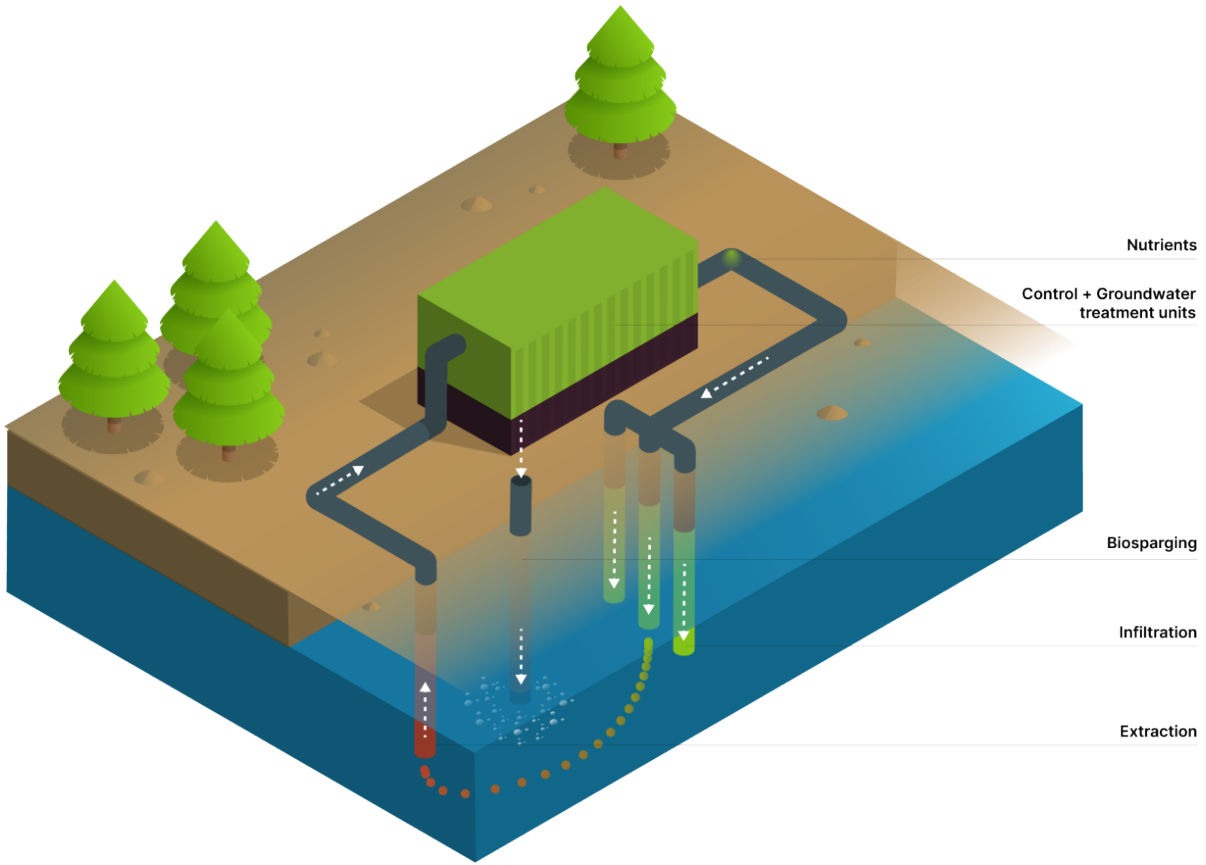
In-situ groundwater treatment





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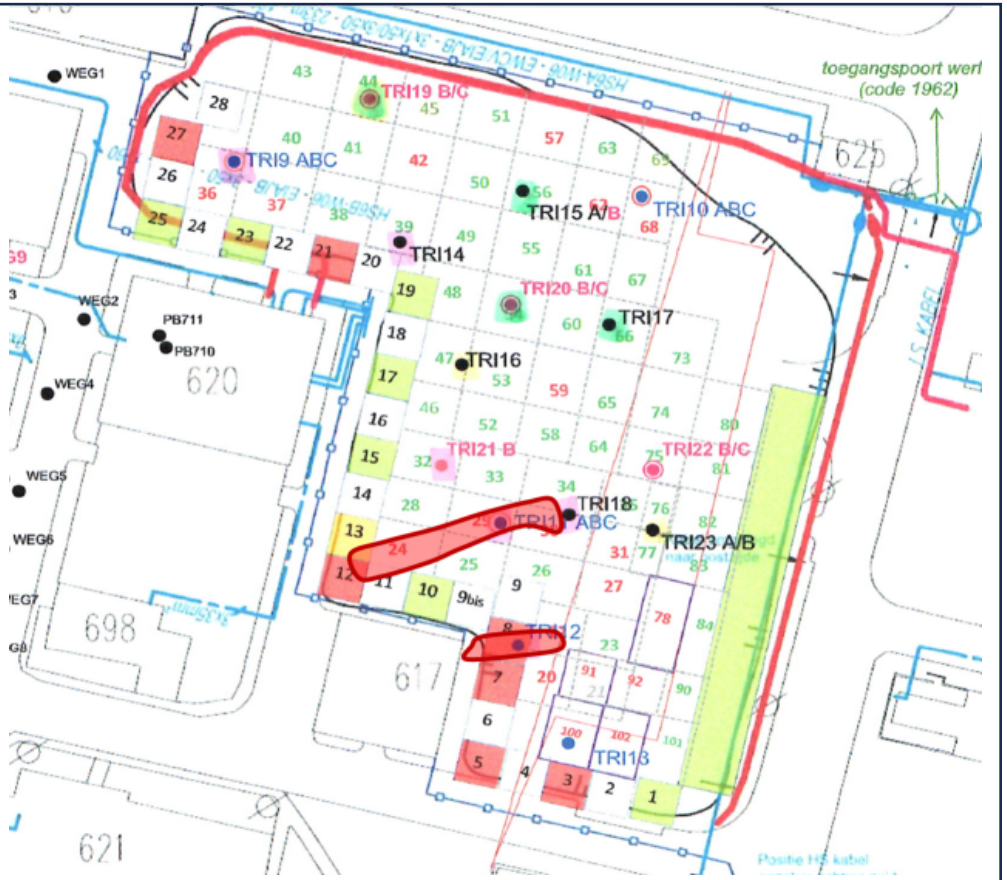
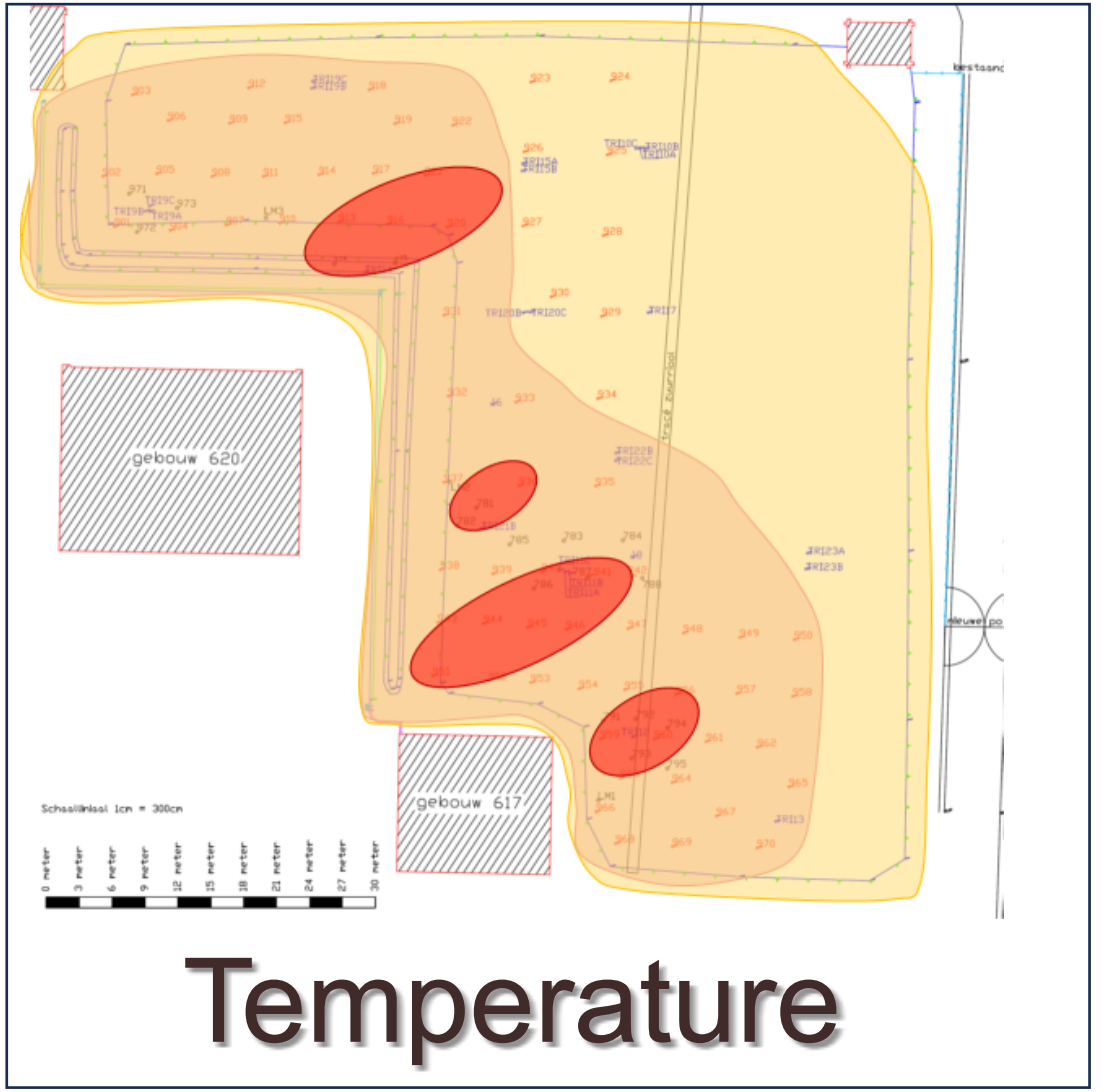
In-situ groundwater evolution (2020>2022)



Contamination



Temperature

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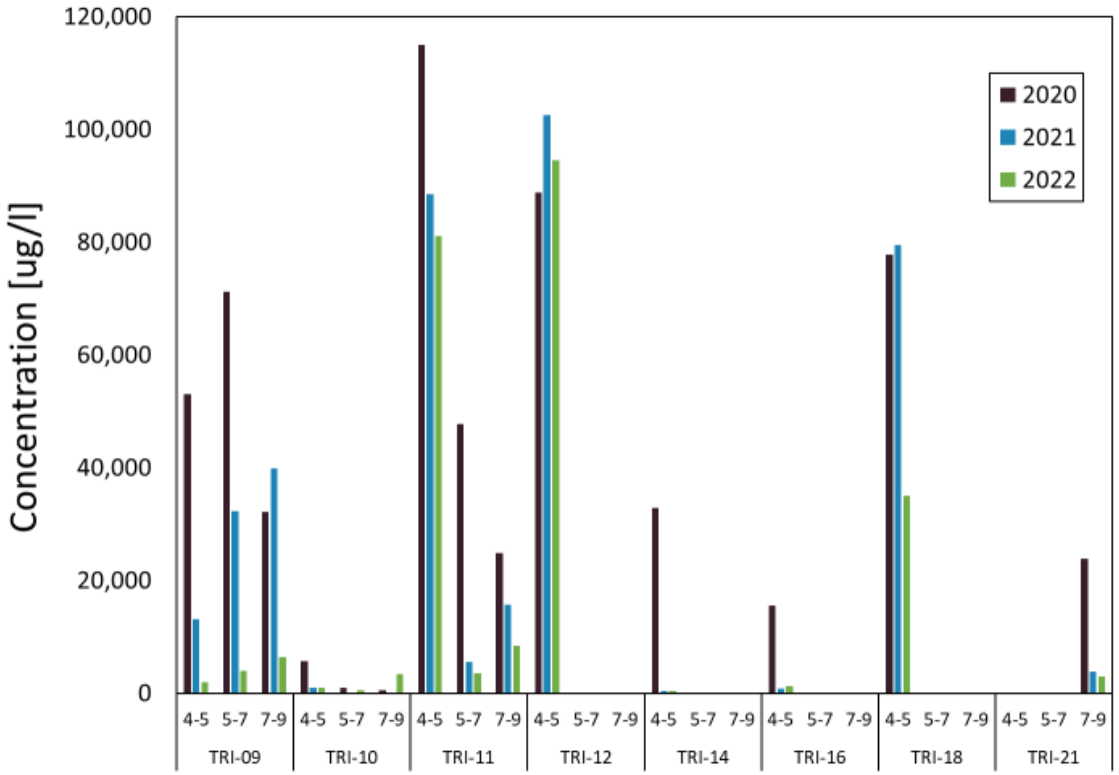
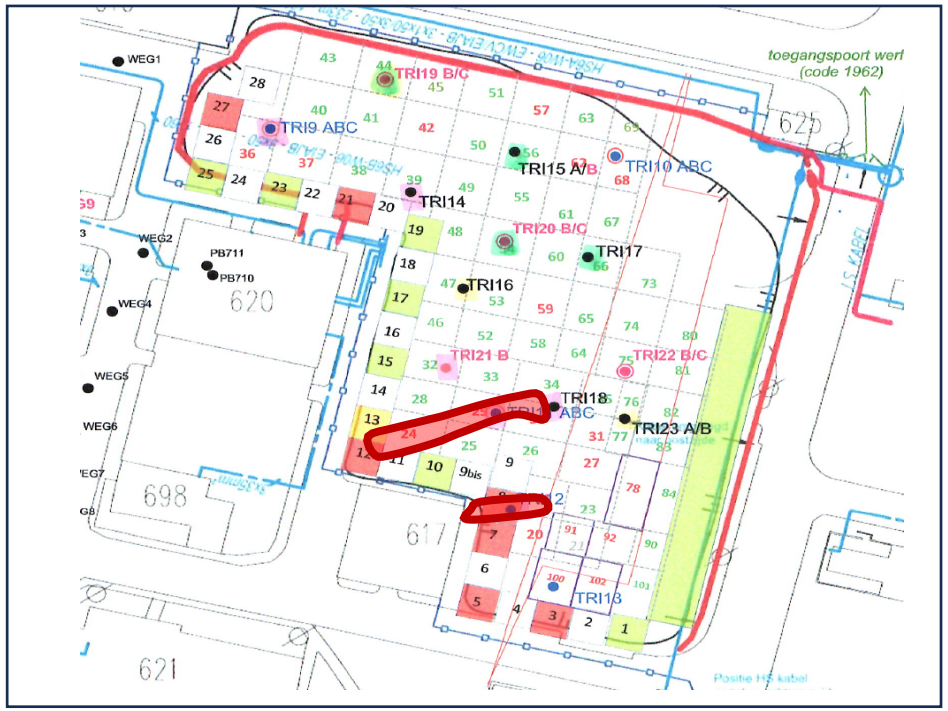
In-Situ Groundwater Results

The impacted groundwater was treated by biosparging with up to 99% decrease of concentration levels.

→Biosparging is a non-invasive techniques





Case study #2

Bioremediation of a cVOC plume with integrated construction of a windmill

Former telecommunication site contaminated with cVOCs. Two source zones contaminated with TCA (up to 200,000 µg/l) and PCE (100,000 µg/l) to a depth of 21 m-bgl. A groundwater plume of about 400 m was formed.

Challenges due to presence of multiple stakeholders and the construction of a windmill on top of one of the source areas.

Contamination type:	**cVOCs**
Approach:	**Anaerobic**
Contract type:	**Risk based**
Period:	**2018 - 2026**
Contract value:	**2,000 – 2,500 k€**

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Site Background

Contamination

- TCA (30 ppm) and TCE (50 ppm)
- Limited degradation products
- Depth = 21 m-bgl

Project background

- Bioremediation already unsuccessfully applied
- Conflict of interests

→ Construction of a windmill on top of a source area

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Site Background

Contamination

- TCA (30 ppm) and TCE (50 ppm)
- Limited degradation products
- Depth = 21 m-bgl

Project background

- Bioremediation already unsuccessfully applied
- Conflict of interests

→ Construction of a windmill on top of a source area

Fixed price solution by GreenSoil

Transfer of remediation obligation to GreenSoil (2018)

GreenSoil Group

Technical challenges

Location of windmill - Relocation?

- Permit of windmill includes exact location

Foundation on top of most contaminated zone

- Win-win: combination excavation and construction

Recirculation system in source zone below foundation

- Theoretically possible
- Clogging? System not accessible?

Stability

- In the excavated/refilled zone
- Due to recirculation

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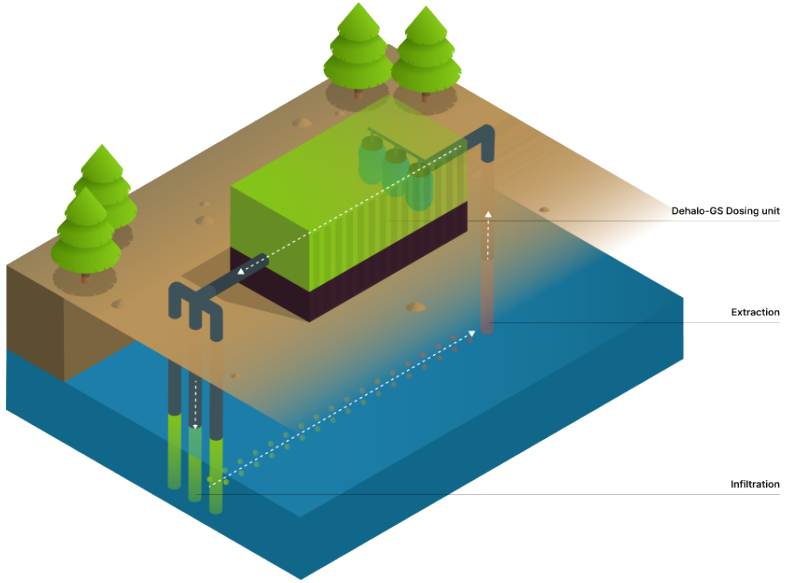
Approach

Excavation

- Source 1 until 9 m-bgl
- Source 2 until 4 m-bgl

Intensified Source Recirculation

- In-situ Anaerobic bioremediation until 21 m-bgl



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Approach

Excavation

- Source 1 until 9 m-bgl
- Source 2 until 4 m-bgl

Intensified Source Recirculation

- In-situ Anaerobic bioremediation until 21 m-bgl

Windmill construction

- Mutual collaboration for foundation design

GreenSoil Group

Approach

Excavation

- Source 1 until 9 m-bgl
- Source 2 until 4 m-bgl

Intensified Source Recirculation

- In-situ Anaerobic bioremediation until 21 m-bgl

Windmill construction

- Mutual collaboration for foundation design

Biobarriers (plume)

- 4 biobarriers
- 3 deep wells

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Integration redevelopment

In-situ system in excavation area

- Injection/extraction wells within the piled foundation
- Windmill foundation adapted to recirculation system underneath
- Safety margins: “overdesign” – prepare for the worst-case

Groundwater recirculation

TOC

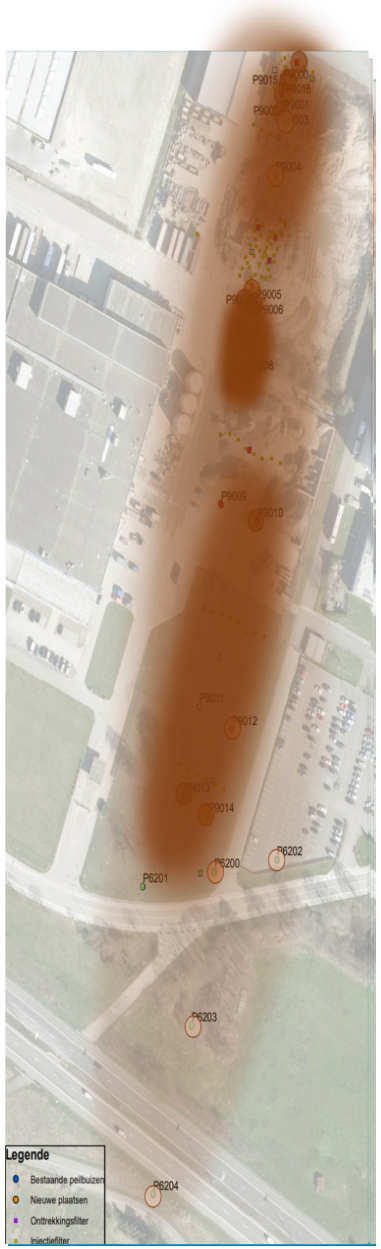
Oct 2019
12 m³/h

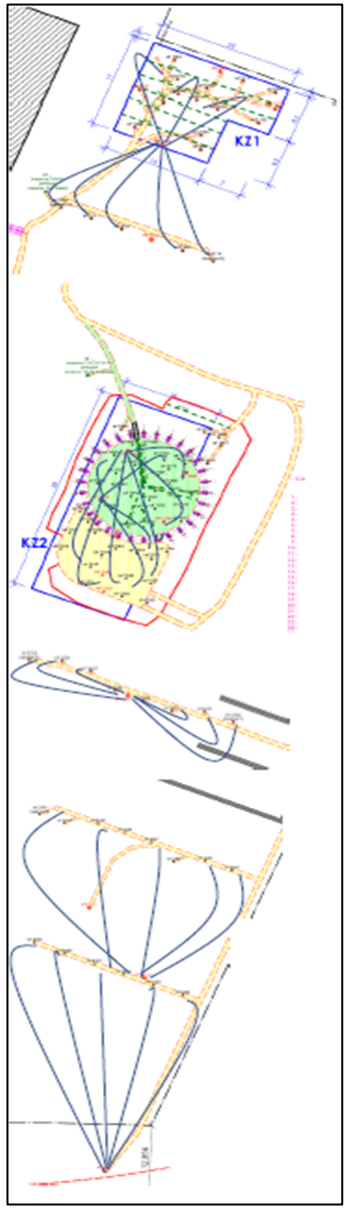
Jan 2020
12 m³/h

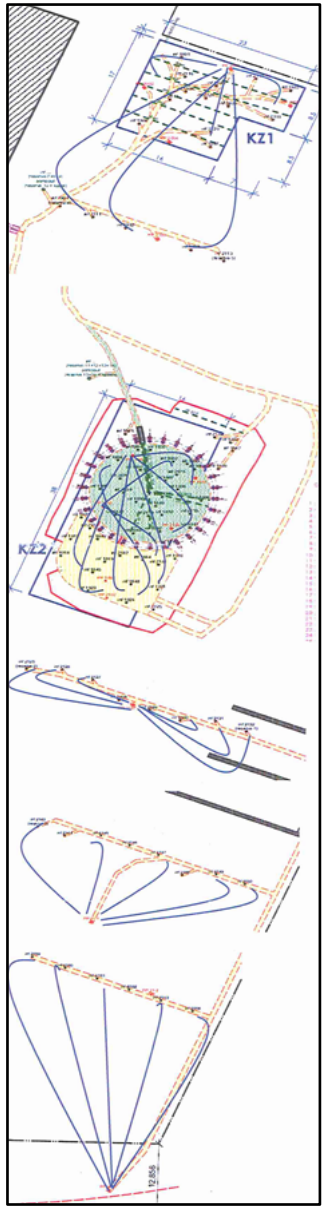
Feb 2020
8 m³/h

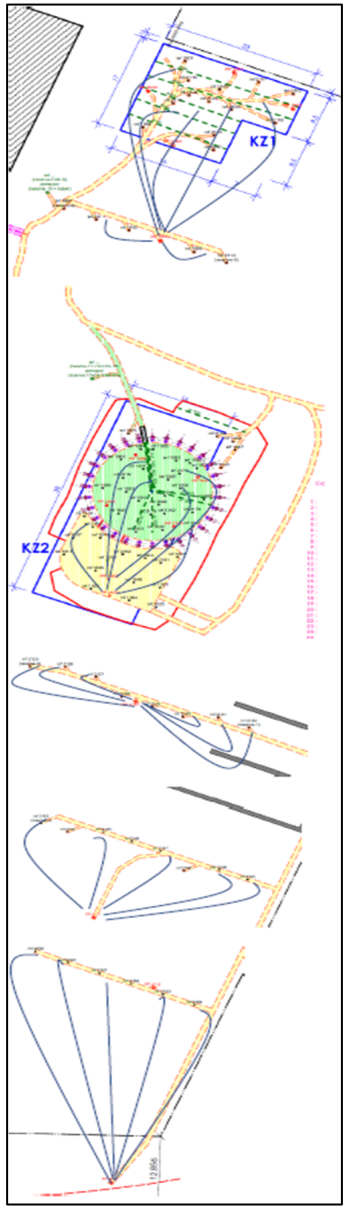
Apr 2020
8 m³/h

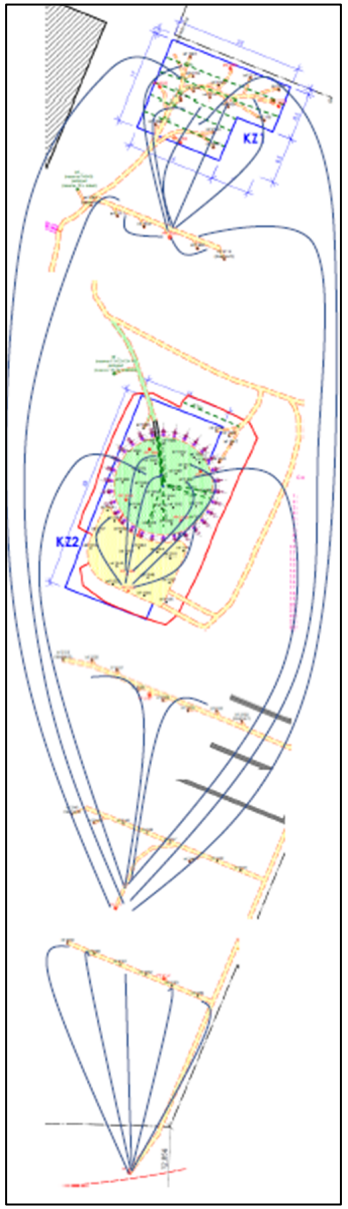
Oct 2020
3 m³/h

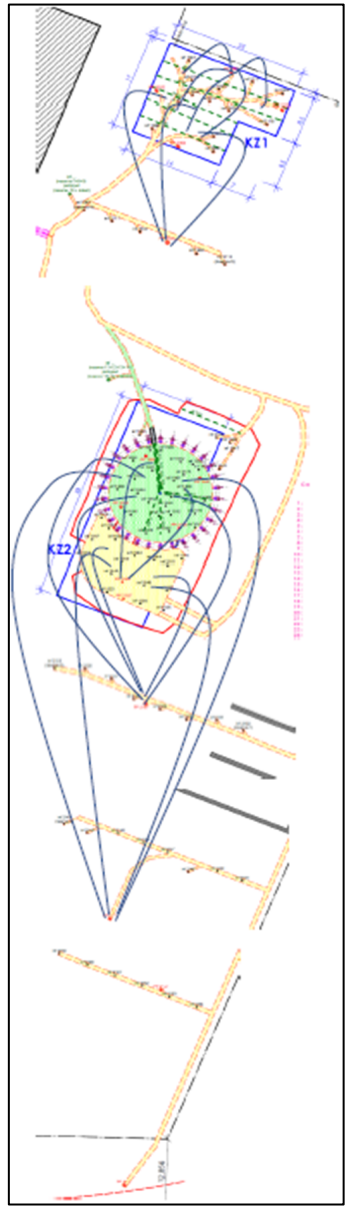












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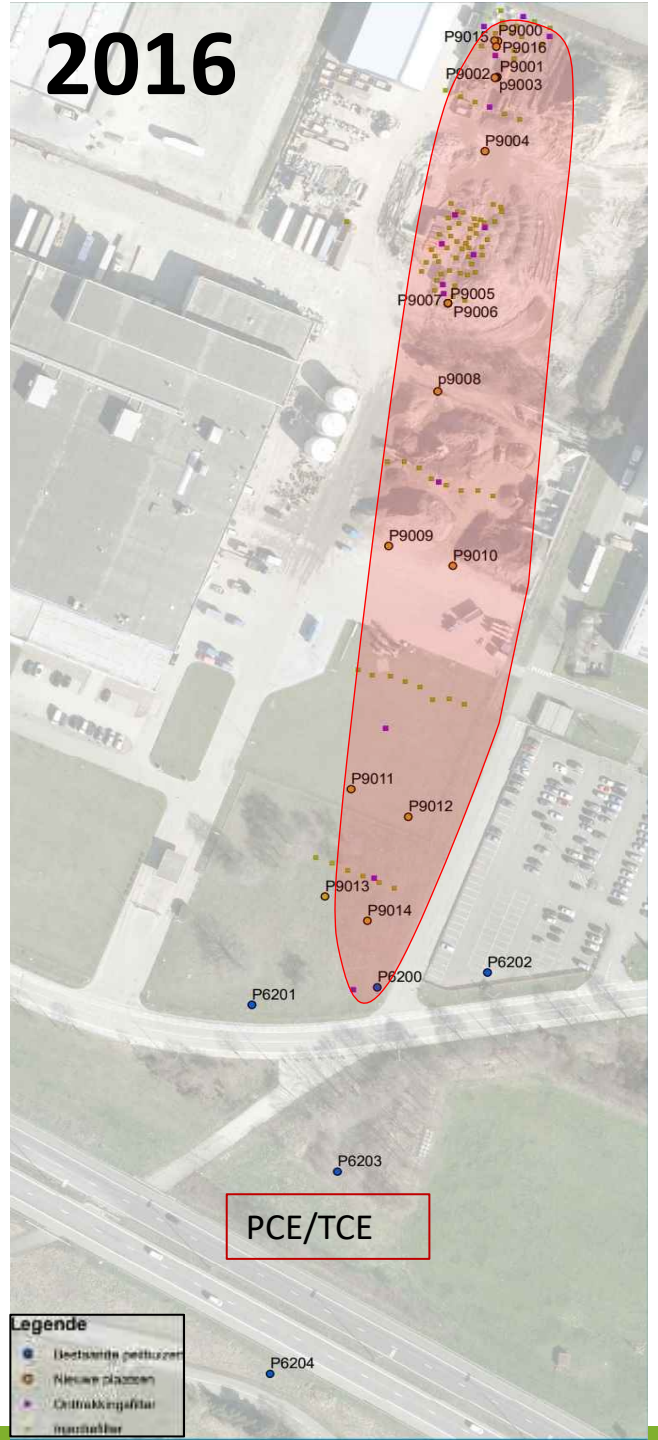
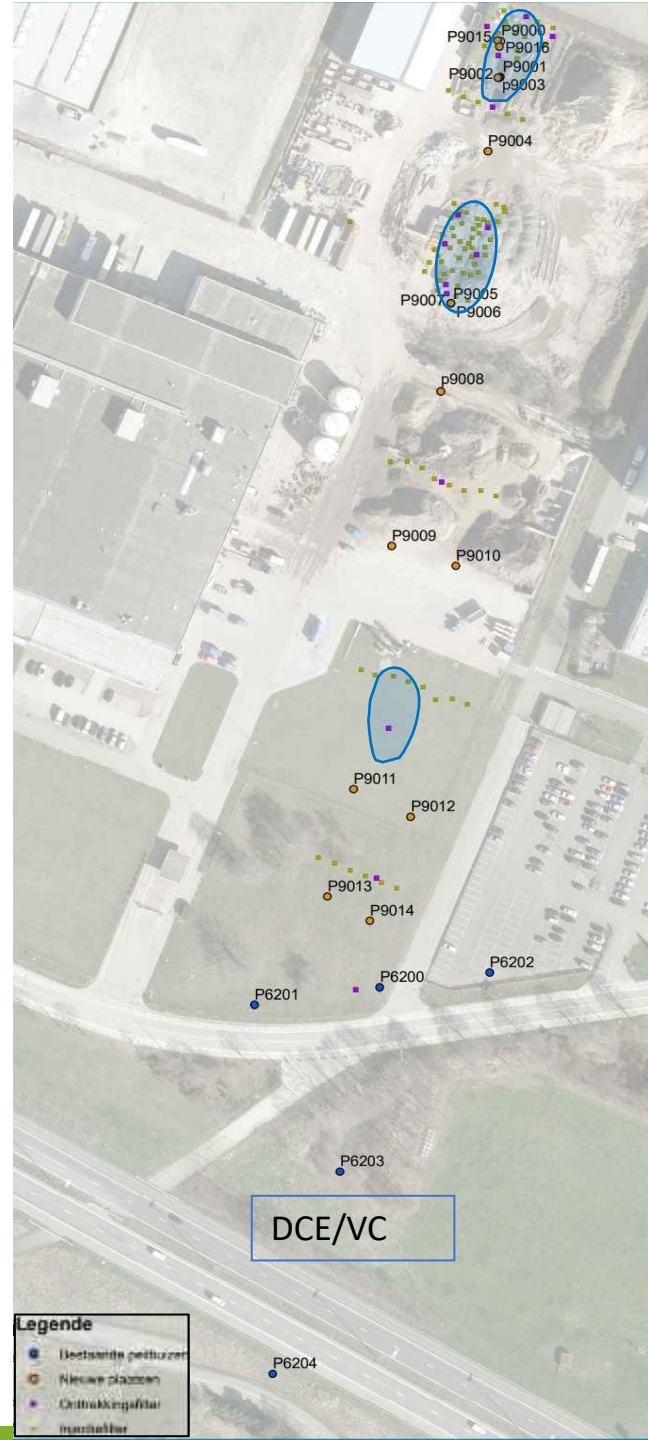
Remediation Results





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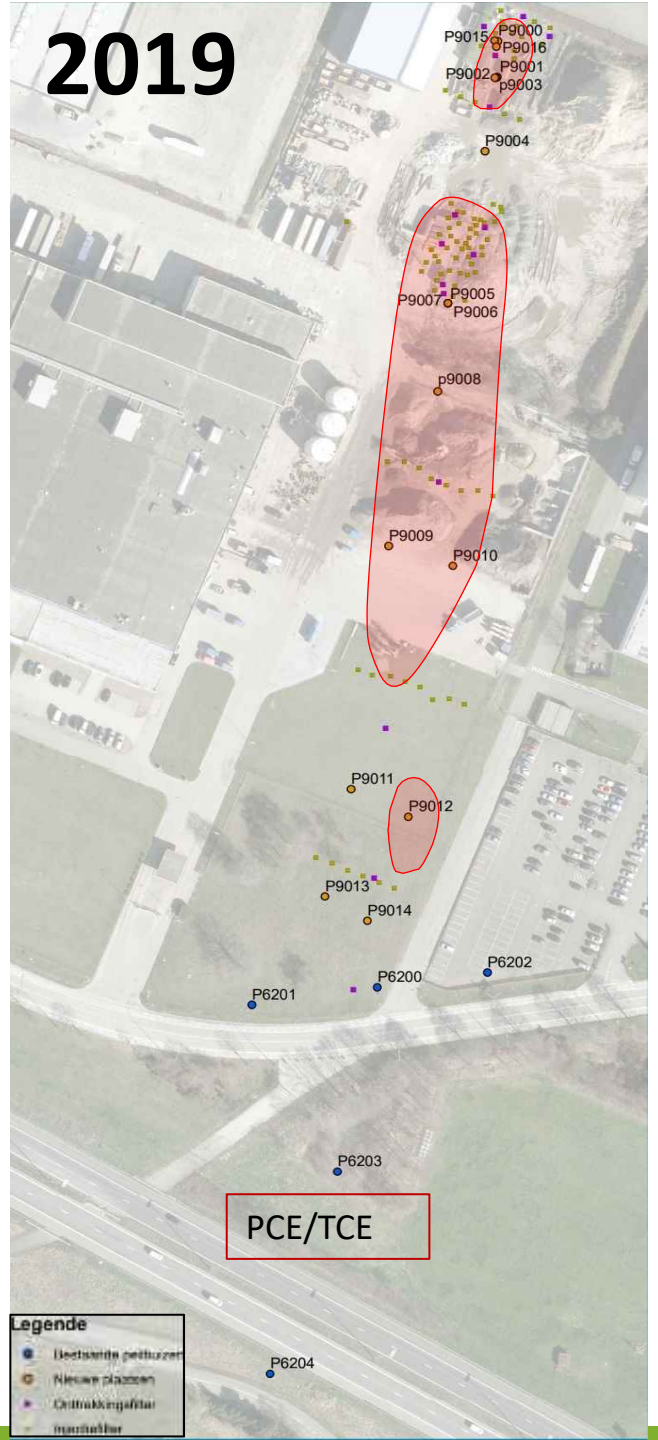

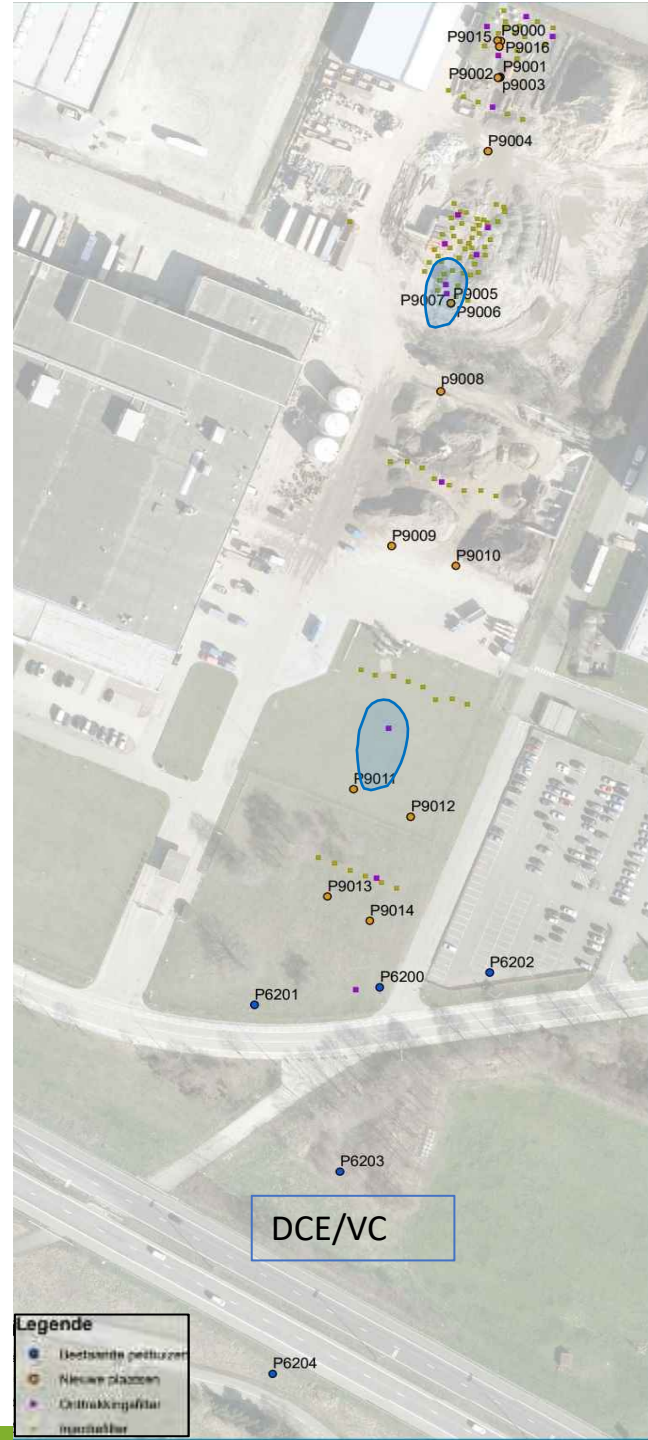

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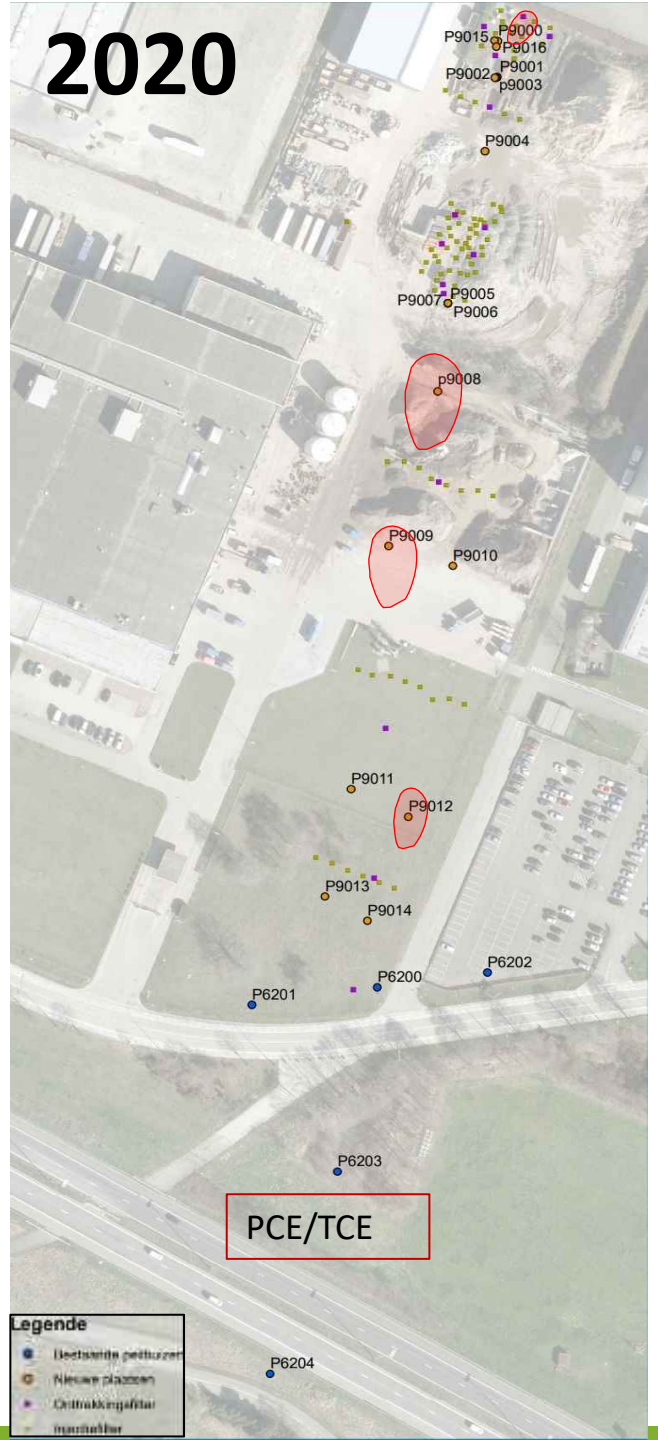

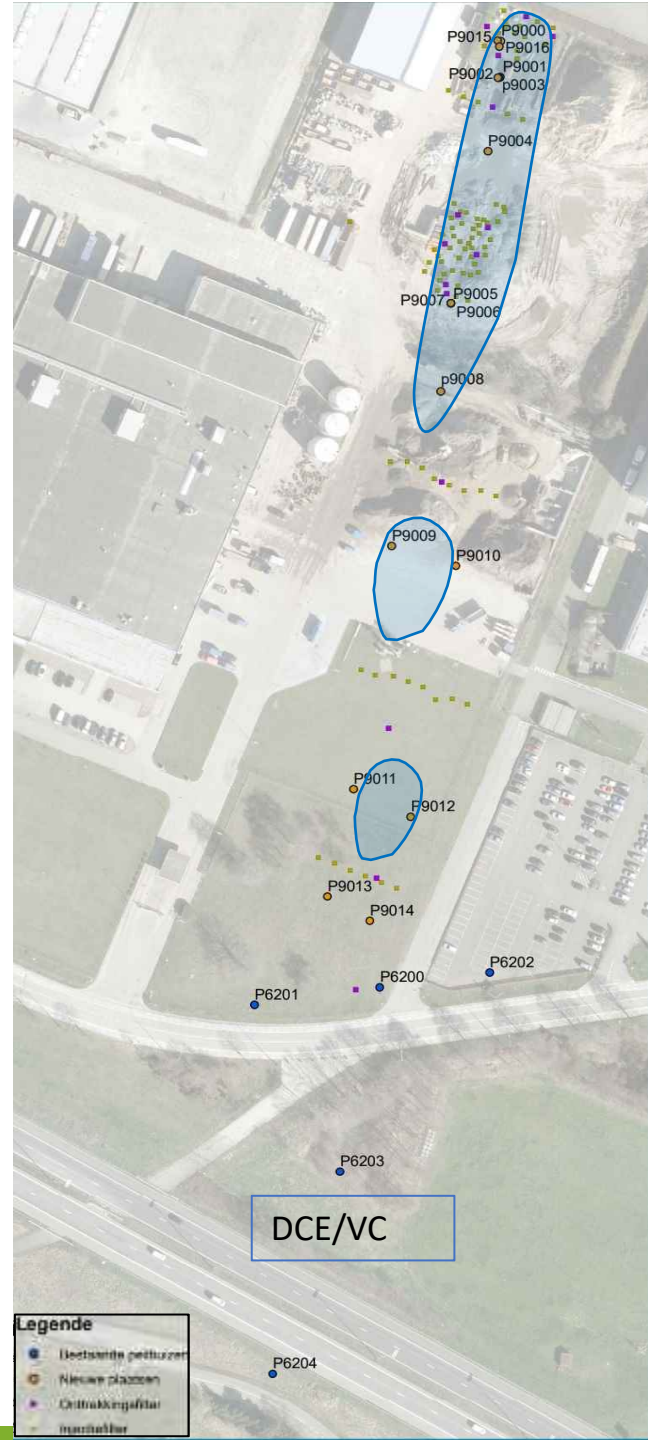

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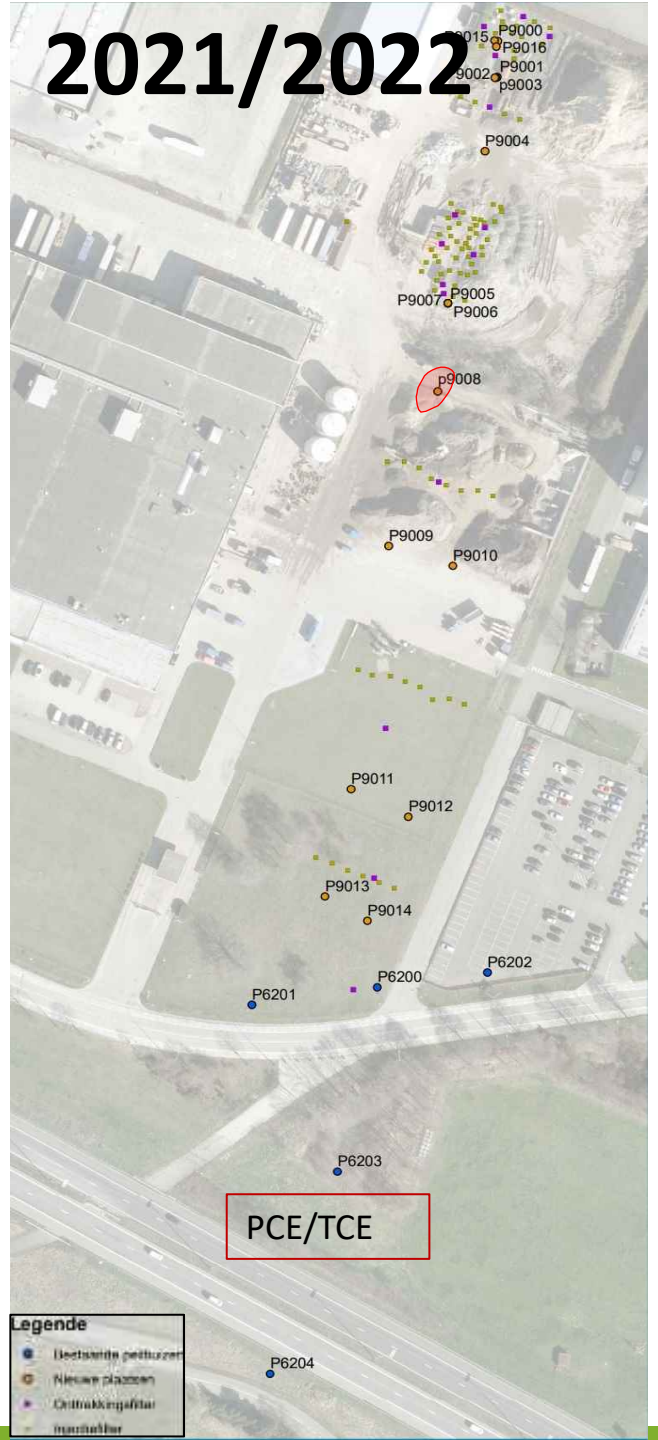

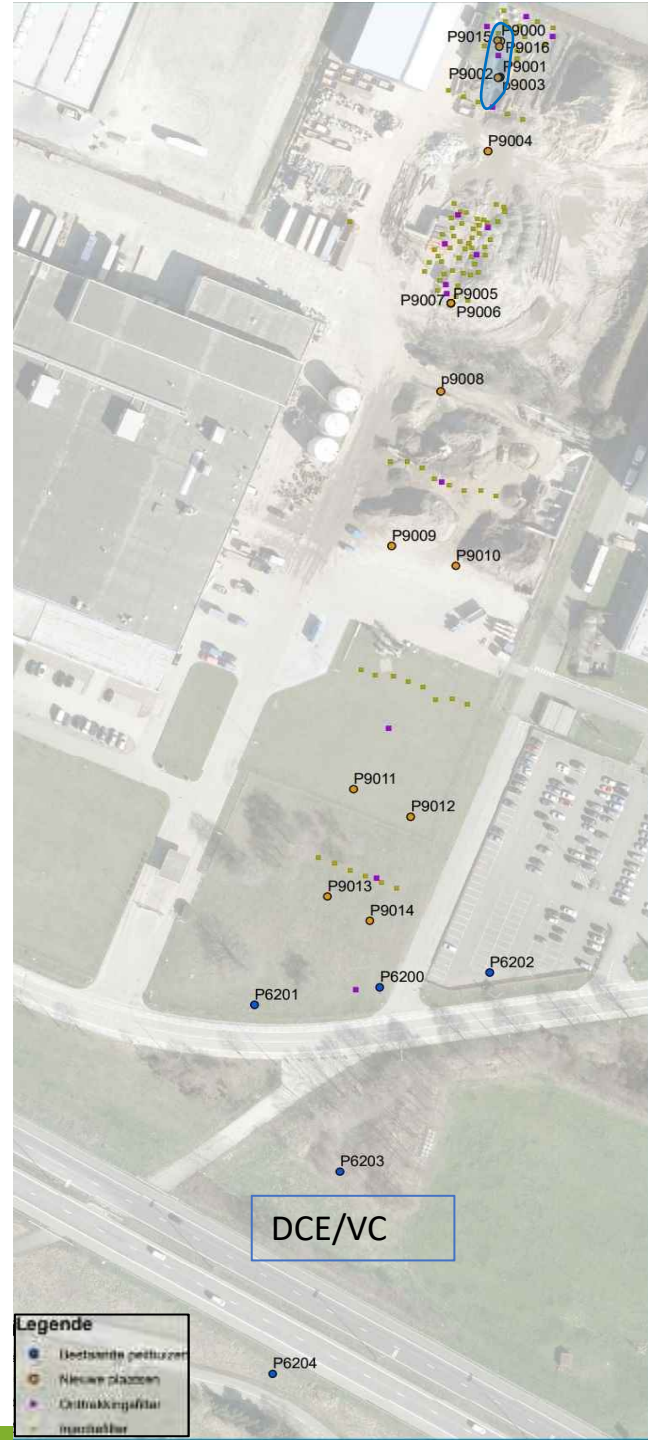

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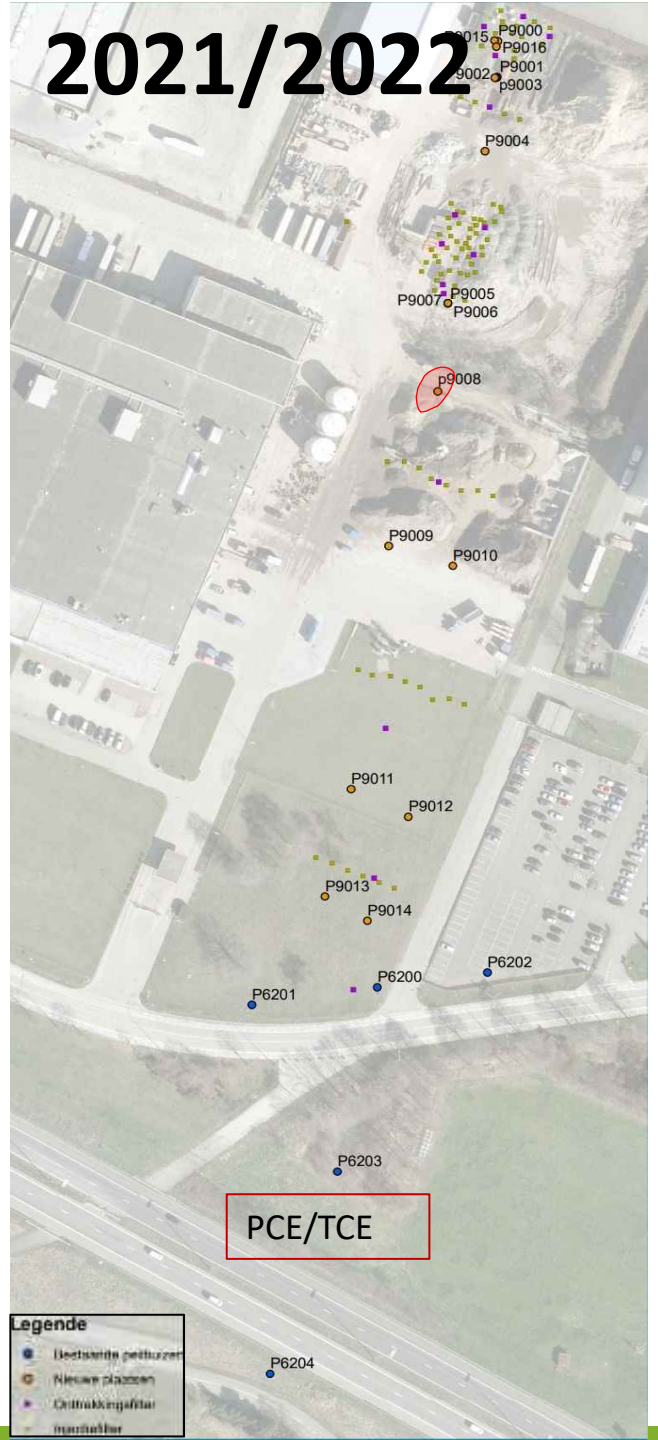
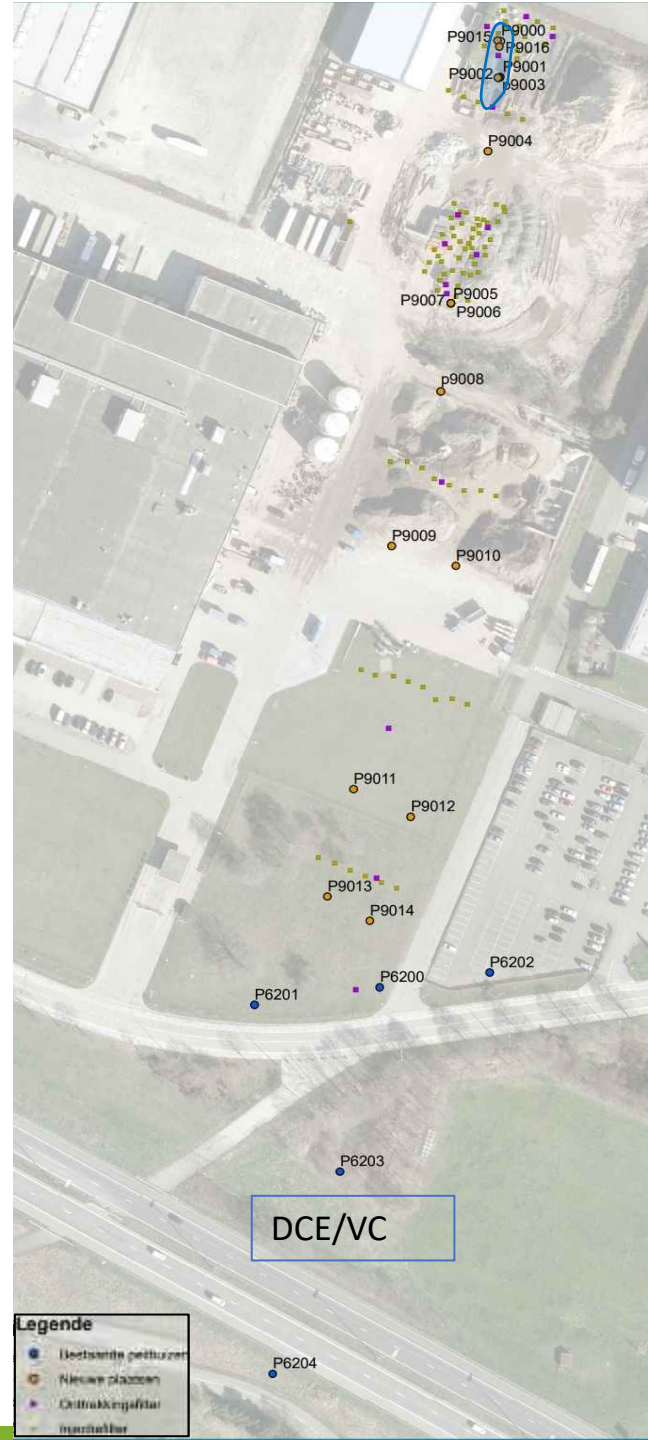
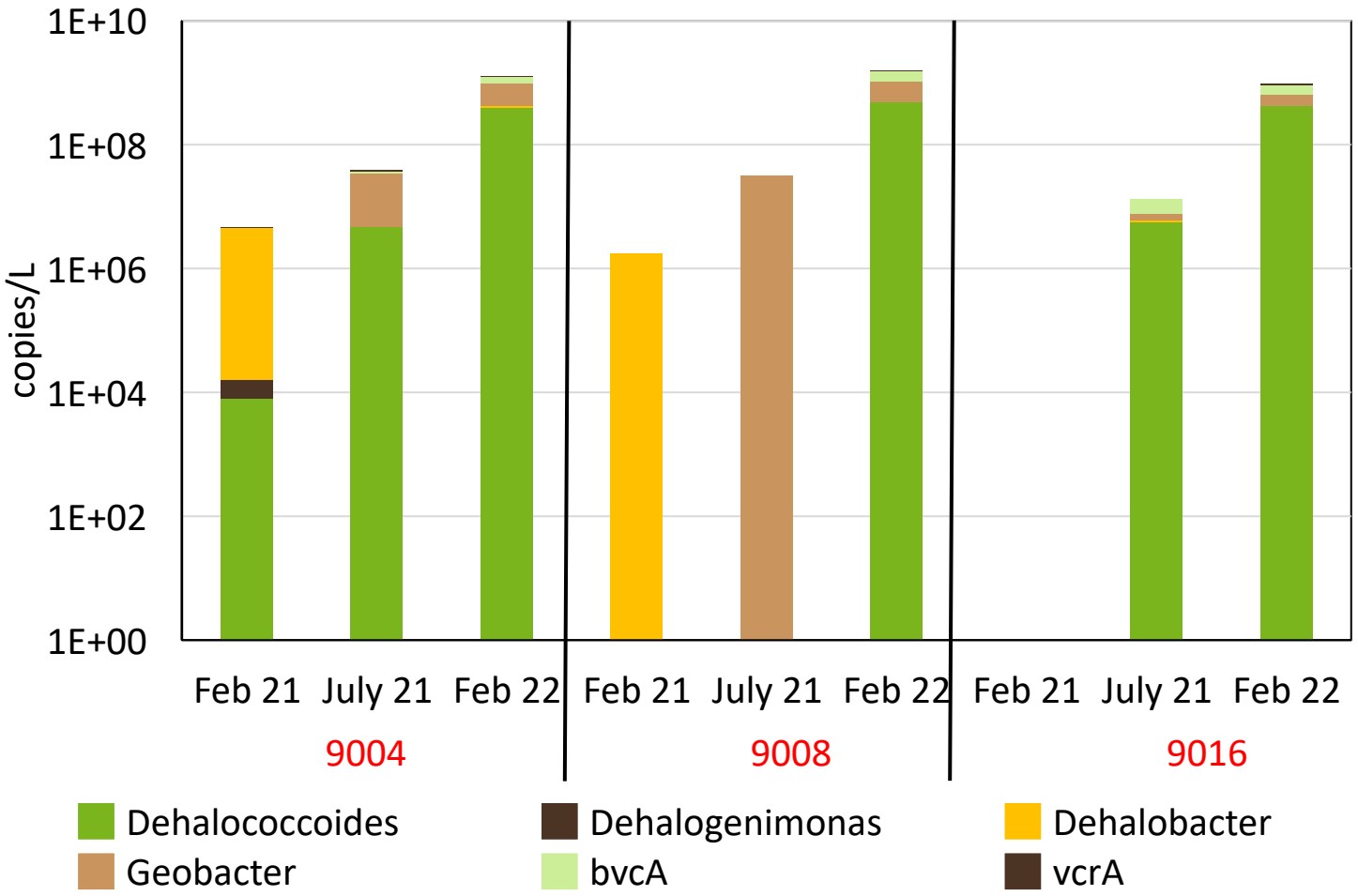
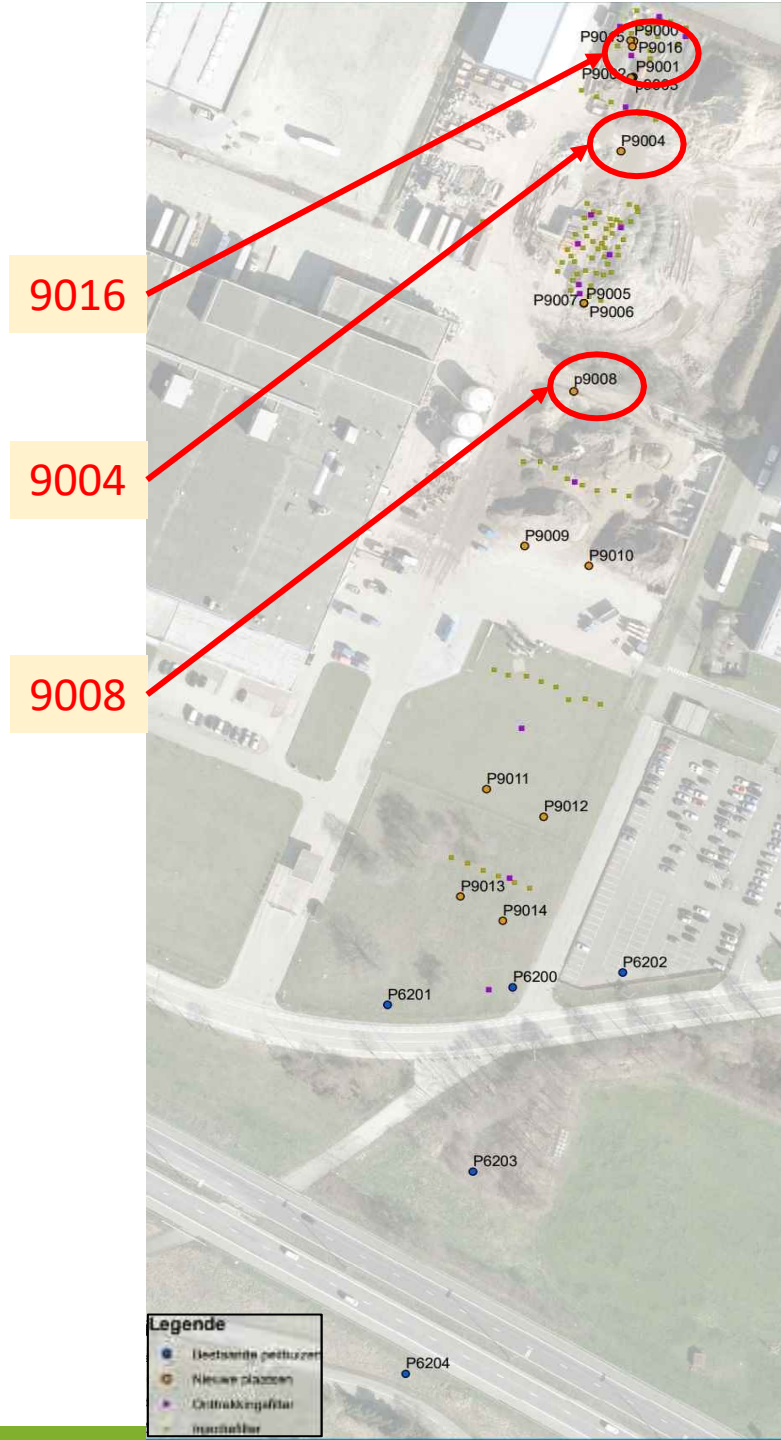
Remediation Results





Microbial monitoring (qPCR)





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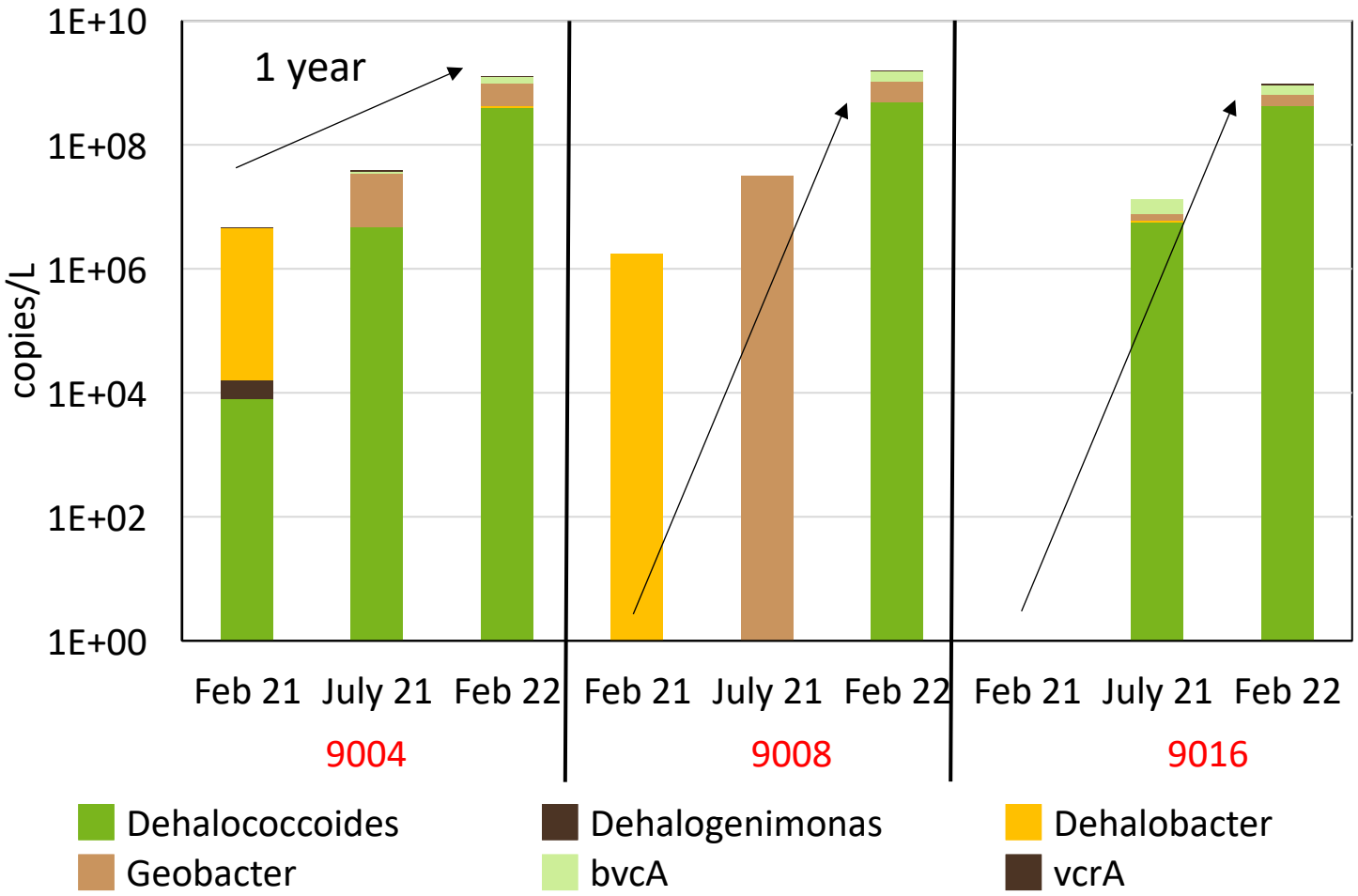

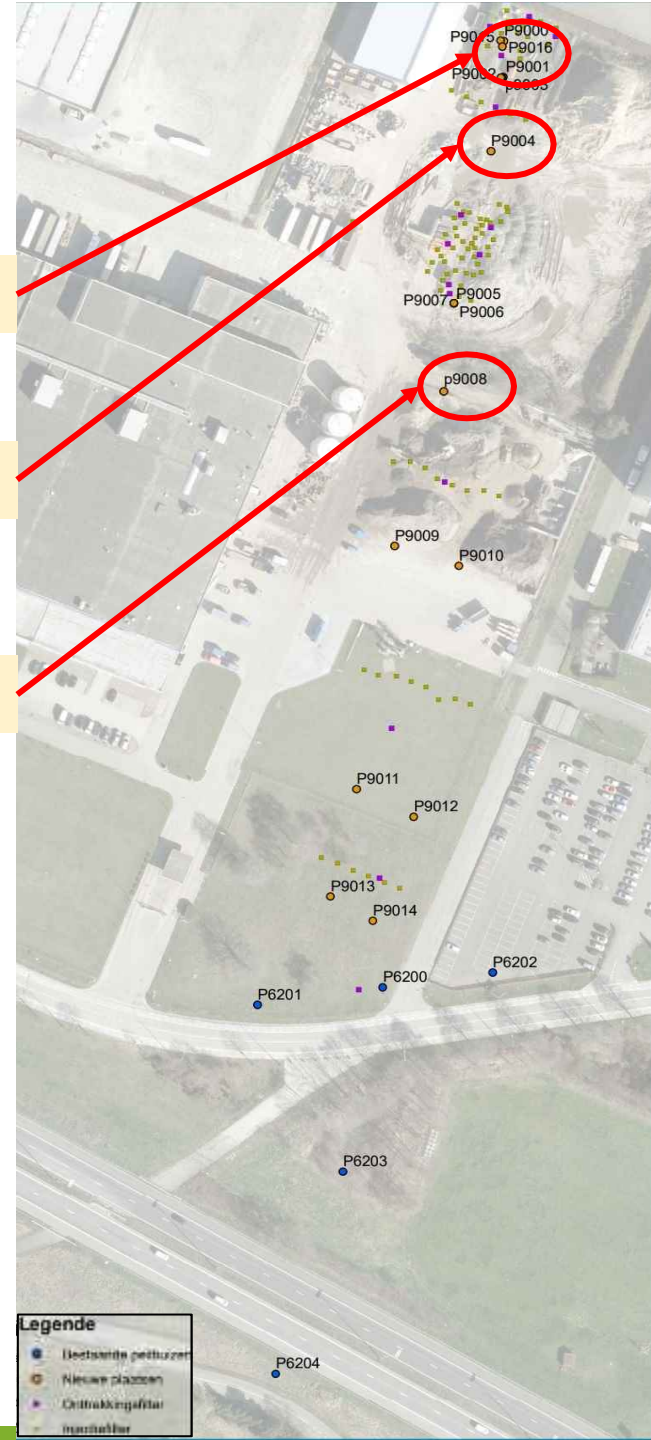

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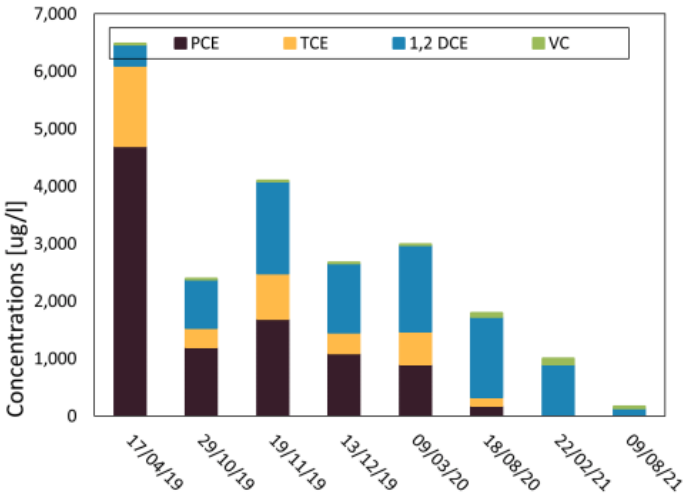
Remediation Results

Source 1



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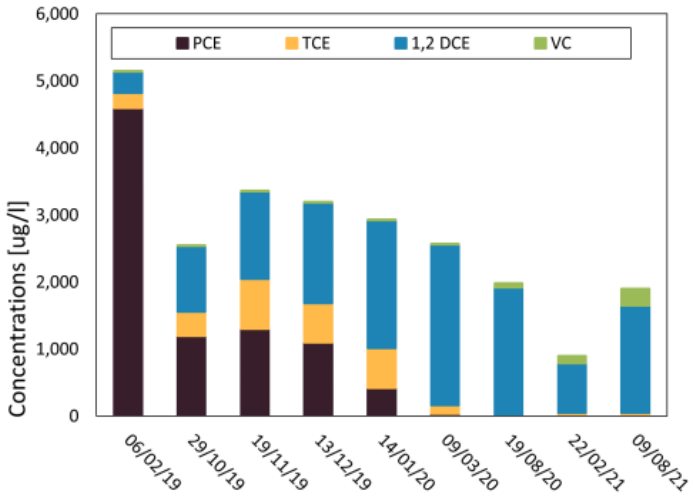
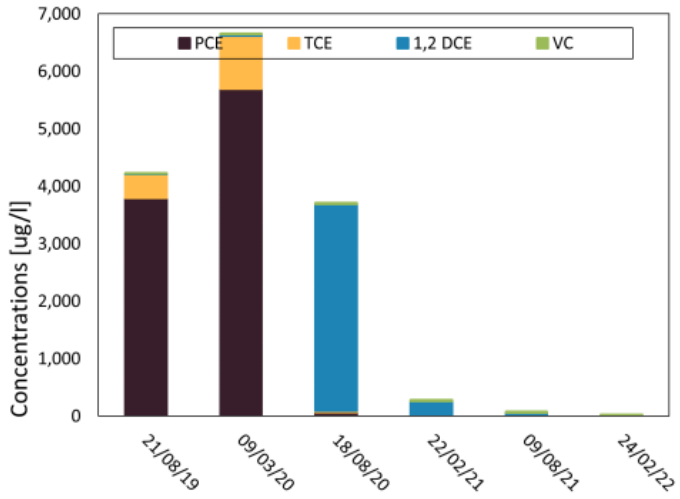


Plume



Prognosis

- 2022: stop active remediation

  → annual monitoring 3-5 years

- 2026: end of the remedial liability

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Bioremediation with Sustainable Redevelopment

On-site remediation

- Risk reduction for subsequent redevelopment

Contaminant removal

- Removal or degradation of contaminant
- Long-term vision

Circular use of materials

- Reduce waste
- Limit transport emissions

Integrated design

- Combine remediation with redevelopment

Cost-effective

- Sustainable and on-site treatments
- Integration saves time

Thank you for your attention. Questions?

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