Fedexsol
october, 13 2015

Vlabotex npo
Flemish soil remediation fund for drycleaning sites

PROGRAM

Part 2

Technical operation of VLABOTEX npo

Bert Opgenhaffen
Project leader

Soil remediation of dry cleaners - Problems

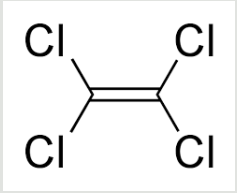
90 % operated with tetrachloorethene (PCE)

Former contamination caused by:

- spills with PCE and PCE containing waste (sludge / contactwater)
- overfilling of the dry cleaning system
- leakage of the sewer system

Soil- and groundwater contamination with PCE and degradation products

tetrachloroethene (PCE)



⇩

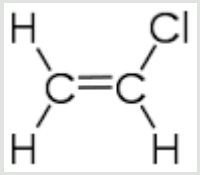
trichloroethene (TCE)

⇩

dichloroethene (DCE)

⇩

vinylchloride (VC)

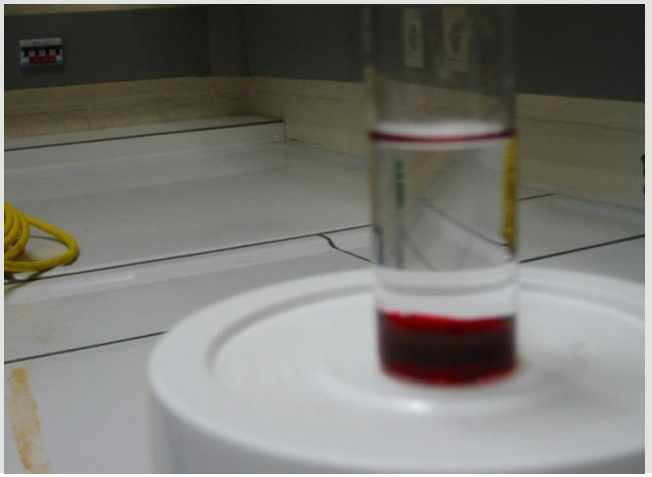


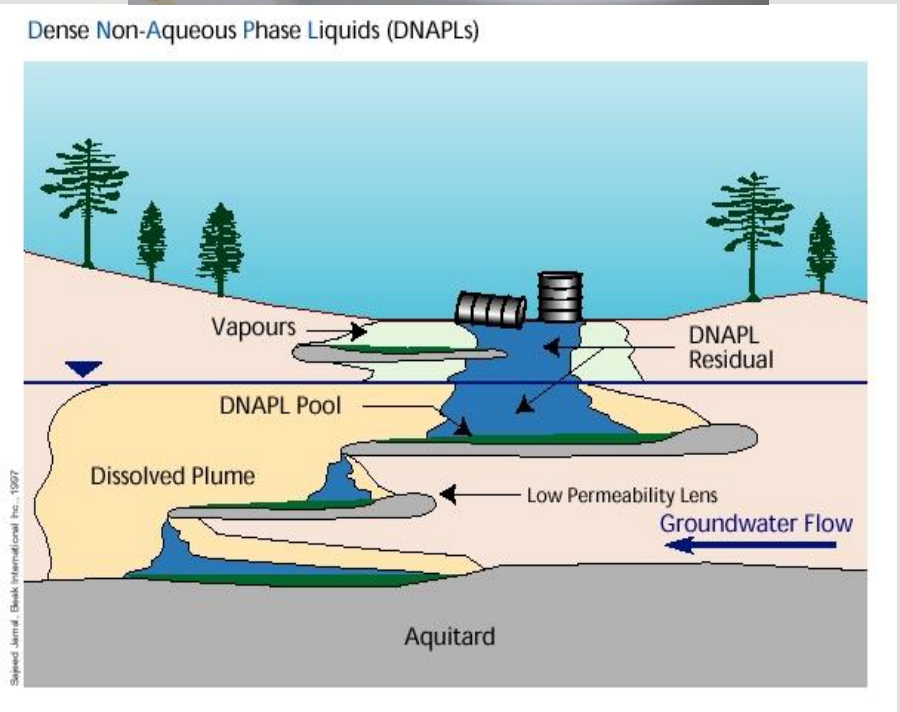
1.
Soil remediation of dry cleaners

Problems

Chlorinated solvents

- dense non-aqueus phase (DNAPL)
- immiscible-liquid phase
- denser than water
- volatile (path-way: inhalation!)
- toxic
- recalcitrant
- very low solubility
- complex migration patern in the soil





1.
Soil remediation of dry cleaners

Problems

- Major pollution areas in urban zone
  - presence of buildings
  - proximity of residents / receptors
  - path ways: drinking water, inhalation air,…

- Poor financial capacity of the dry cleaners, the cost of the soil remediation often exceeds:
  - financial strength of the company/owner
  - value of the property

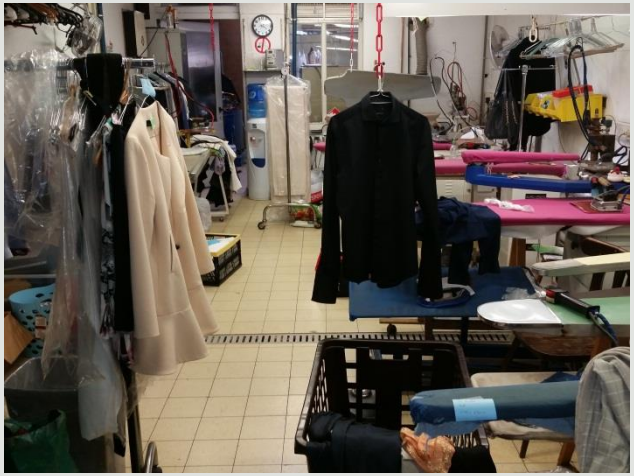
- Soil investigation & remediation is difficult and expensive

⇒ **abandoned sites / brownfields / city cancers**

1.
Soil remediation of dry cleaners

Problems

Where drilling????



1.
Soil remediation of dry cleaners

Solution

Solution!

The professional federation (FBT) of the dry-cleaners did great efforts to set up a soil remediation organisation VLABOTEX npo.

Principles:

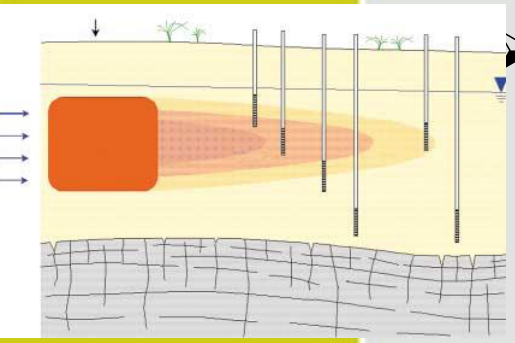
- limited financial strenght of the dry cleaning sector
- the ‘the polluter pays’ principle
- financial strenght of the individual applicant has to be taken in account
- defined contribution with subsidy (till 50%)

2.
Why a new Code of good practice VLABOTEX?

2. A new guideline: how to deal with pollution of chlorinated solvent caused by (former) dry cleaners: Code of Good Practice VLABOTEX

- intention: how to make soil investigation & remediation technically and economically feasible?

- (very) limited VOC-remediation works are successful till today
  - contamination due to dry cleaning process is characterized by a core zone (pure product). This zone contains the bulk of the mass (> 80%) while < 10% of the volume.

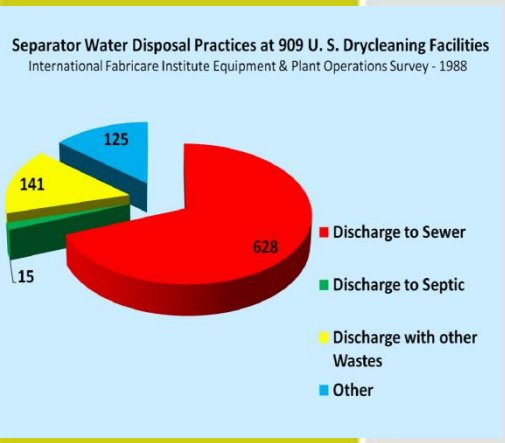


2.
Why a new Code of good practice VLABOTEX?

- previous soil investigations mainly focused on VOCl plume & not/less on core zone
- very expensive / inefficient / never-ending remediation works
  ⇒ many failures
- CGP: focus on core zone

- behavior of VOC in soil requires a special investigation & remediation approach

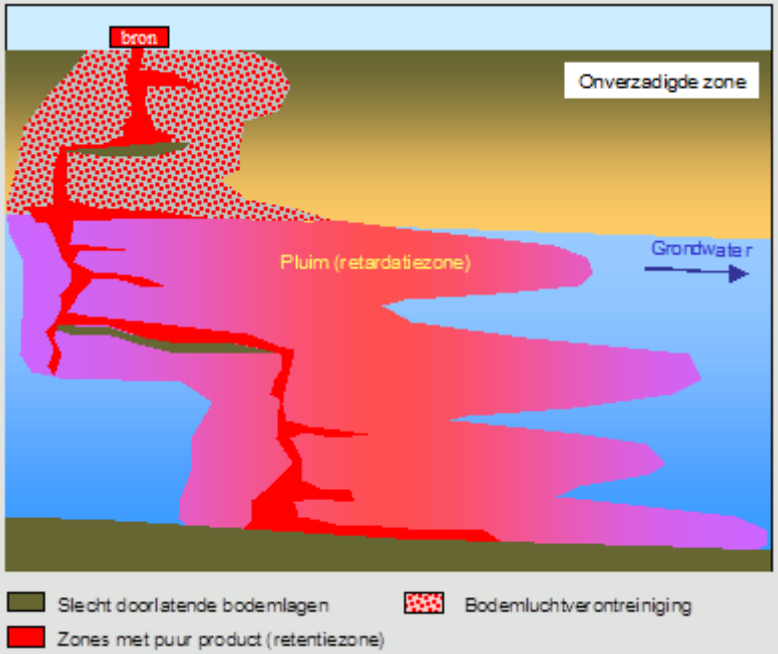
- more efficient methods for soil investigations needed: stimulation of the fast screening methods (PID, liners, Red Oil, MIP,…)



2. Why a new Code of good practice VLABOTEX?

- sufficient screening of all potential sources of contamination is necessary
  - ➢ historical research
  - ➢ sewerage: 67 % Vlabotex sites
  - ➢ most probably related to contact water

- focus on hydrogeology



2.
Why a new Code of good practice VLABOTEX?

- quality standard for soil investigations and remediation works ⇒ lessons learned !?!

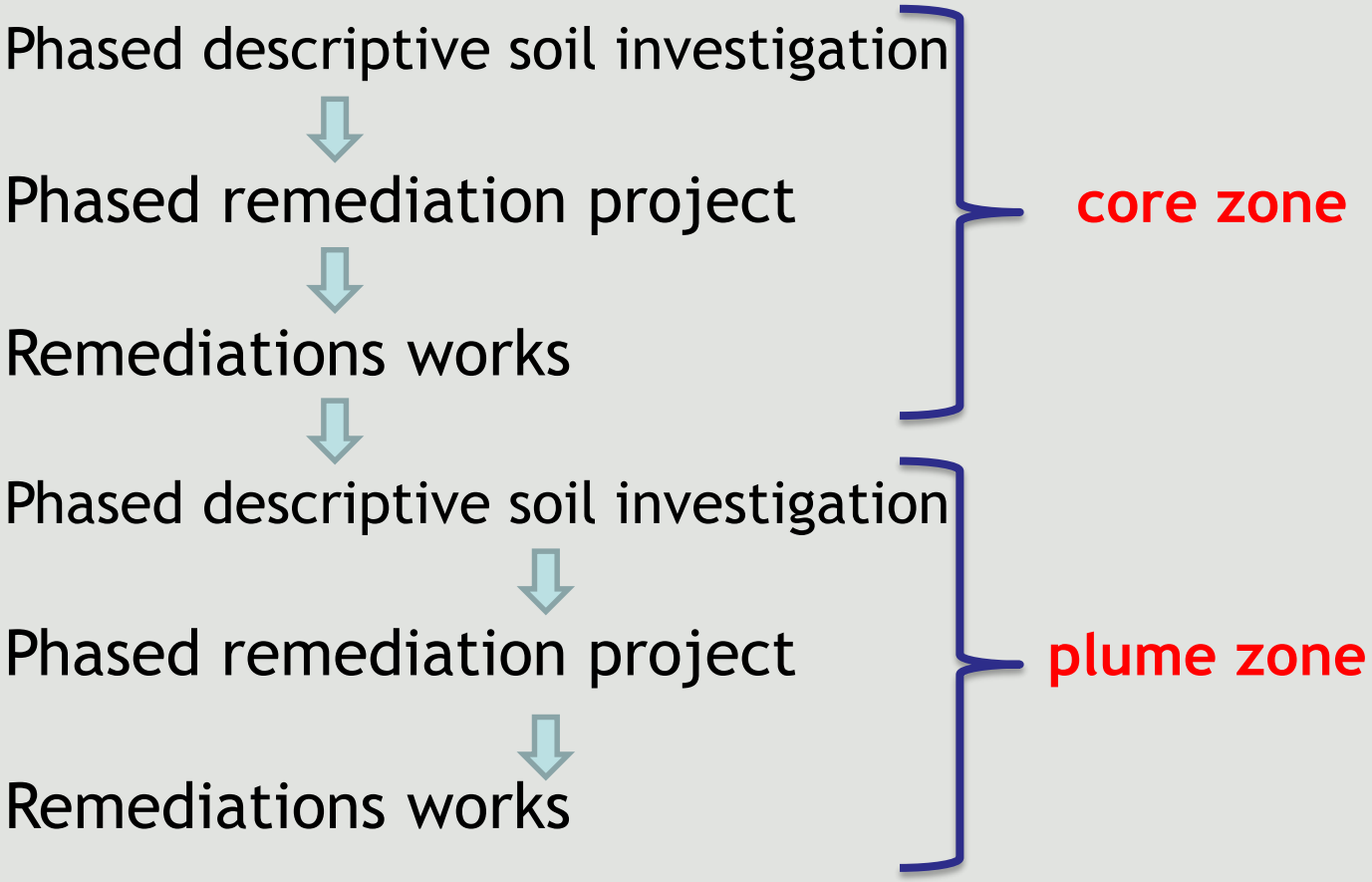
- public money: investigation and remediation as cost-efficiently as possible (BATNEEC)

CGP VLABOTEX: new approach in VOC-treatment

FIRST THE CORE ZONE THEN THE PLUME ZONE.

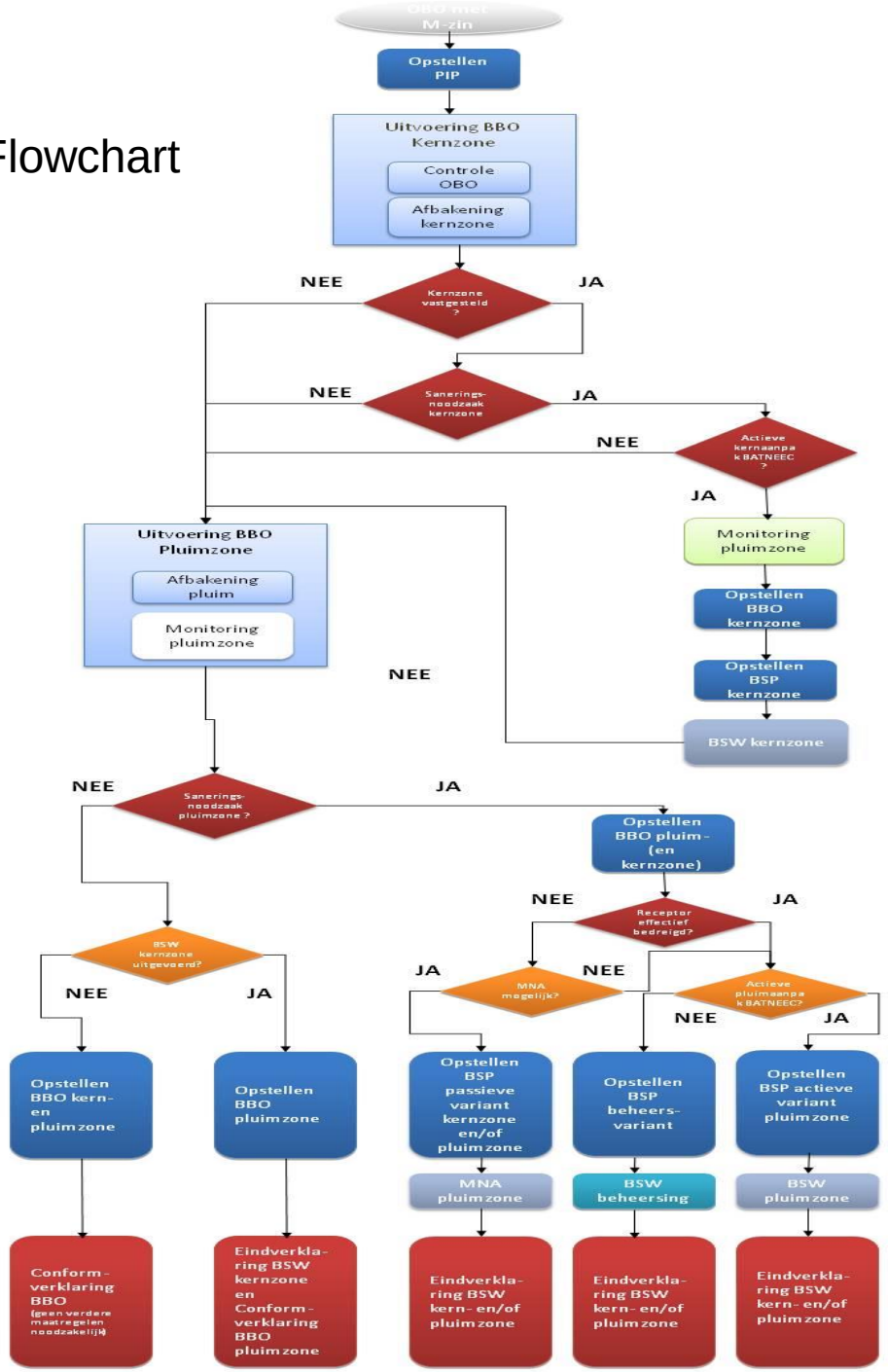
3. Overview procedure for the soil remediation

Overview of the operation procedure



3. Overview procedure

Flowchart



Phase 1 :
Phased descriptive soil investigation core zone

Core zone: *zone where the contamination in the soil is in the form of pure product. This covers both the zone with residual product and the zone of free product and contamination adsorbed to soil particles in the saturated and unsaturated zone.*

AIMS:

- detailed screening of potential contamination sources, gaps former investigations
- detailed delineation core zone (horizontal & vertical contour)
- risk analysis : determine present & potential human risk (exposure routes) / distribution risk and ecotoxical risk

3. Overview procedure

Phased descriptive soil investigation – core zone

- Plume migration & potential risk to receptors
- Attention to field work!
  - soil sampling: metal core sampling
  - groundwater sampling: filter fully into saturated zone
  - **fast screening methods**
    - ✓ PID measurements in plastic bag
    - ✓ Liners (detail description geology)
    - ✓ Soil vapor measurements
    - ✓ MIP probing (screening vertical distribution of contaminant)
    - ✓ Red oil test (pure product test)

Manual drilling
soil sampling VOC: metal core

3. Overview procedure

Phased descriptive soil investigation – core zone

fieldwork

Volatile compounds metal cylinder sampling

Phased descriptive soil investigation – core zone

fieldwork

PID measurements

fast screening methods

Phased descriptive soil investigation – core zone

PID measurements

fast screening methods
Phased descriptive soil investigation – core zone

fieldwork

PID measurements

fast screening methods

Phased descriptive soil investigation – core zone

Boring	diepte	PID	Analyses grond	mg/kg (>BSN)	analyse grondwater (µg/l)
P201	0-40	74			
700-800	40-80	260			**PER: 44**
	80-120	260			
	120-160	6040**	120-160	**PER: 2600**	
	160-200	5020**			
	200-240	2500*			
	240-280	2040*			
	280-320	2400*			
	320-360	2000*			
	360-400	200			
	400-440	135			
	440-480	10	440-480	*PER: 0,66*	
	480-520	0			
	520-560	0			
	560-600	0			
	600-640	0			
	640-680	0			
	680-720	0			
	720-760	0			
	760-800	0	760-800	<RW	

Boring	diepte	PID	Analyses grond	mg/kg (>BSN)
B600	0-720	0		
	720-760	0	720-760	<RW
	760-800	182	760-800	**PER: 14**
	800-840	11		
	840-880	0		
	880-920	0		
	920-960	0	920-960	<RW
alcoholstifttest		19		

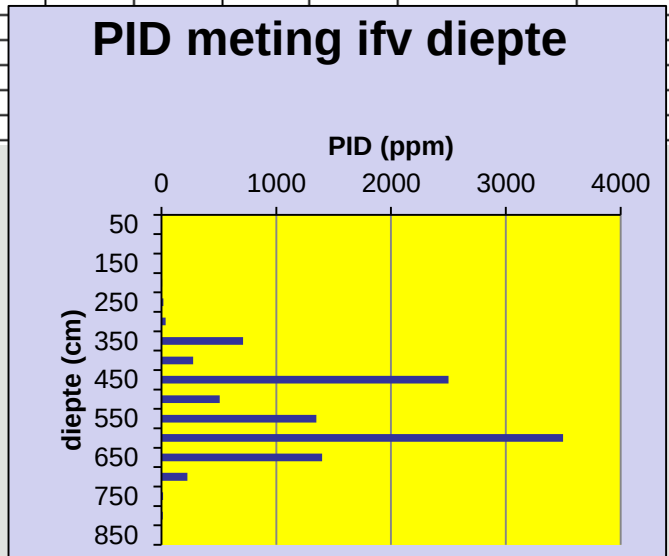
fast screening methods

Phased descriptive soil investigation – core zone

PID

B6011	0-50	0		
	50-100	0		
	100-150	0		
	150-200	0		
	200-250	6,9		
	250-300	12,4		
	300-350	6,6	300-320	*PER: 12*
	350-400	0		
	400-450	2		
	450-500	10,4	500-520	PER< RW**; VC: 3,9; C**
alcoholstifttest		158		
B6003	0-50	0		
	50-100	56		
	100-150	76,8	110-130	*PER: 6,5*
	150-200	410		
	200-250	471		
	250-300	2700*	250-270	*PER: 9,9*
	300-350	280		
	350-400	128		
	400-450	42	400-450	*PER: 2,3*
	450-500	58		
	500-550	22		
alcoholstifttest		178		
B6004	0-50	0		
	50-100	1,7		
	100-150	1,4		
	150-200	9		
	200-250	76,5	200-220	*PER: 3,9*
	250-300	25		
	300-350	169	300-320	*PER: 6,1*
	350-400	45		

Naam boorpunt en filterdiepte (cm -mv)	Zone	Diepte (cm -mv)	PID (ppm)	Analyses grond						Analyse grondwater					Retentiecapaciteit overschreden voor PER?	Opmer
				Staalnamediepte (cm-mv)	Concentratie (mg/kg DS)				OM (%)	Filterdiepte (cm- mv)	Concentratie (µg/l)					
					PER	TRI	CIS	VC			PER	TRI	CIS	VC		
B116		alcohol stift	2830													
		0-50	2,3	20-40	4,1	*0,04*	<0,02	<0,01	0,4							
		50-100	10,3													
		100-150	1,8	100-120	1,5	<0,02	<0,02	<0,01								
		150-200	0,1													
		alcohol stift	2950													
PB117		alcohol stift	3108													
		0-50	10,8	20-40	10	*0,18*	*0,13*	<0,01	0,7							
		50-100	26,9	50-100	46	0,3	*0,15*	<0,01								
		100-150	9,8	100-120	2,9	*0,024*	<0,02	<0,01	0,1							
		150-200	0,4													
		200-250	0													
		250-300	0	250-300	0,54	<0,02	<0,02	<0,01	0,1	200-300	5700	110	150	*0,52*	Neen	
		alcohol stift	3081													
PB118		alcohol stift	3750													
		0-50	0,3	20-40	9,5	0,27	0,23	<0,01								
		50-100	87	50-100	52	0,53	0,27	<0,01								
		100-150	0,5	100-120	61	0,58	0,33	<0,01								
		150-200	0													
		200-250	0							200-300	5900	57	30	<0,1		
		250-300	0,2													
		alcohol stift	3459													
B119		alcohol stift	1450													
		0-50	5,8	20-40	3,8	*0,058*	<0,02	<0,01								
		50-100	3,4													
		100-150	11,2	100-120	7,3	*0,055*	<0,02	<0,01								
		150-200	0,1	180-200	0,32	<0,02	<0,02	<0,01								
		alcohol stift	1324													
PB120		alcohol stift	1319													
		0-50	6,4	20-40	8,6	*0,14*	<0,02	<0,01	1,1							
		50-100	2,1													
		100-150	3,4	100-120	2,6	<0,02	<0,02	<0,01								
		150-200	0													
		200-250	0							170-270						
		250-300	0													



mechanical drilling
Pulsing into the saturated zone

3. Overview procedure

Phased descriptive soil investigation – core zone

fieldwork

mechanical drilling Geoprobe - direct push liners

fast screening methods

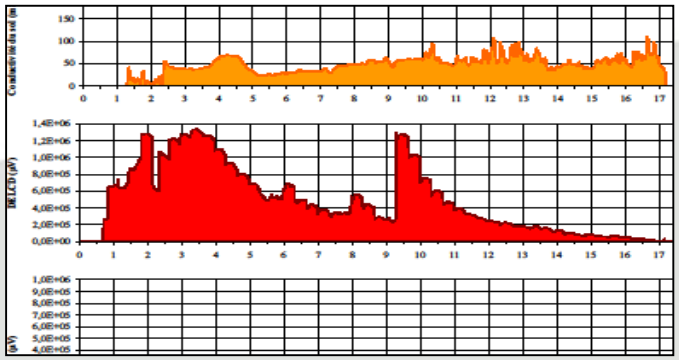
Phased descriptive soil investigation – core zone

fieldwork

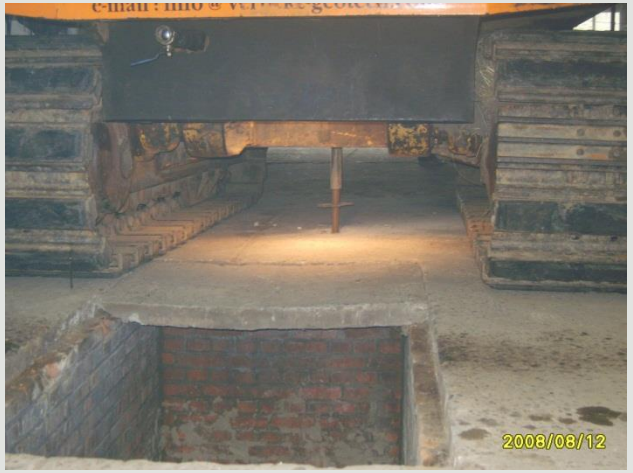
fast screening methods

Phased descriptive soil investigation – core zone

fieldwork



MIP - Membrane Interface Probe

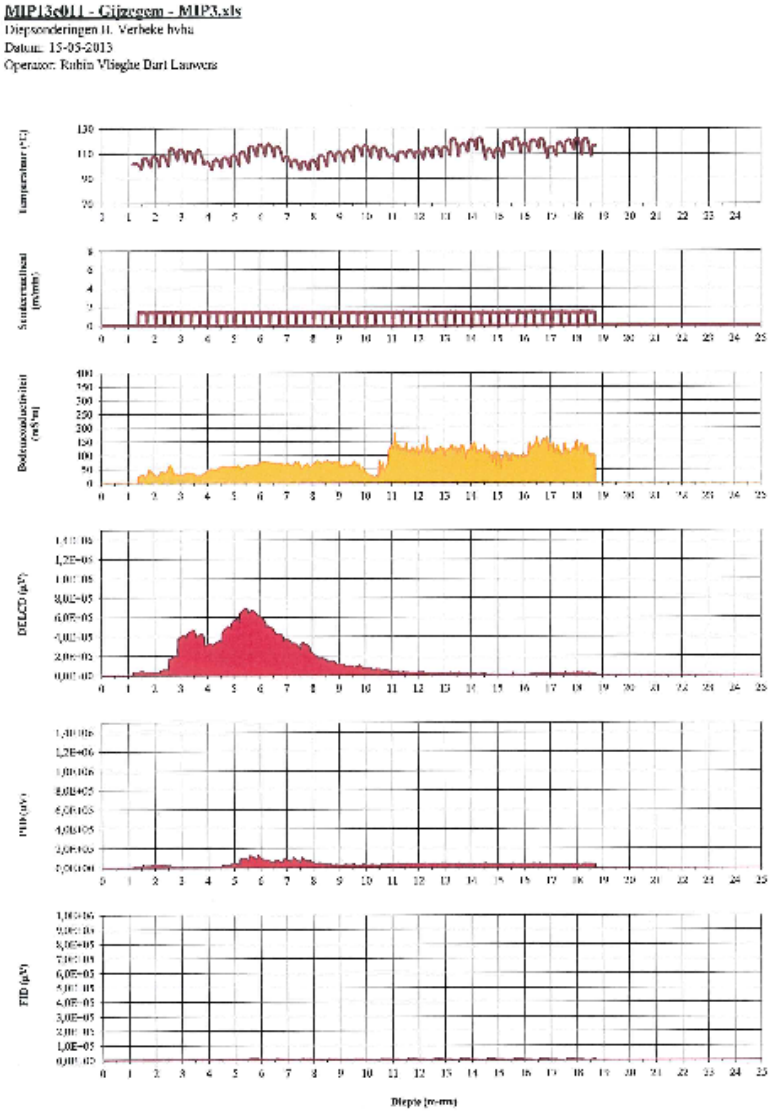


fast screening methods

Phased descriptive soil investigation – core zone

fieldwork

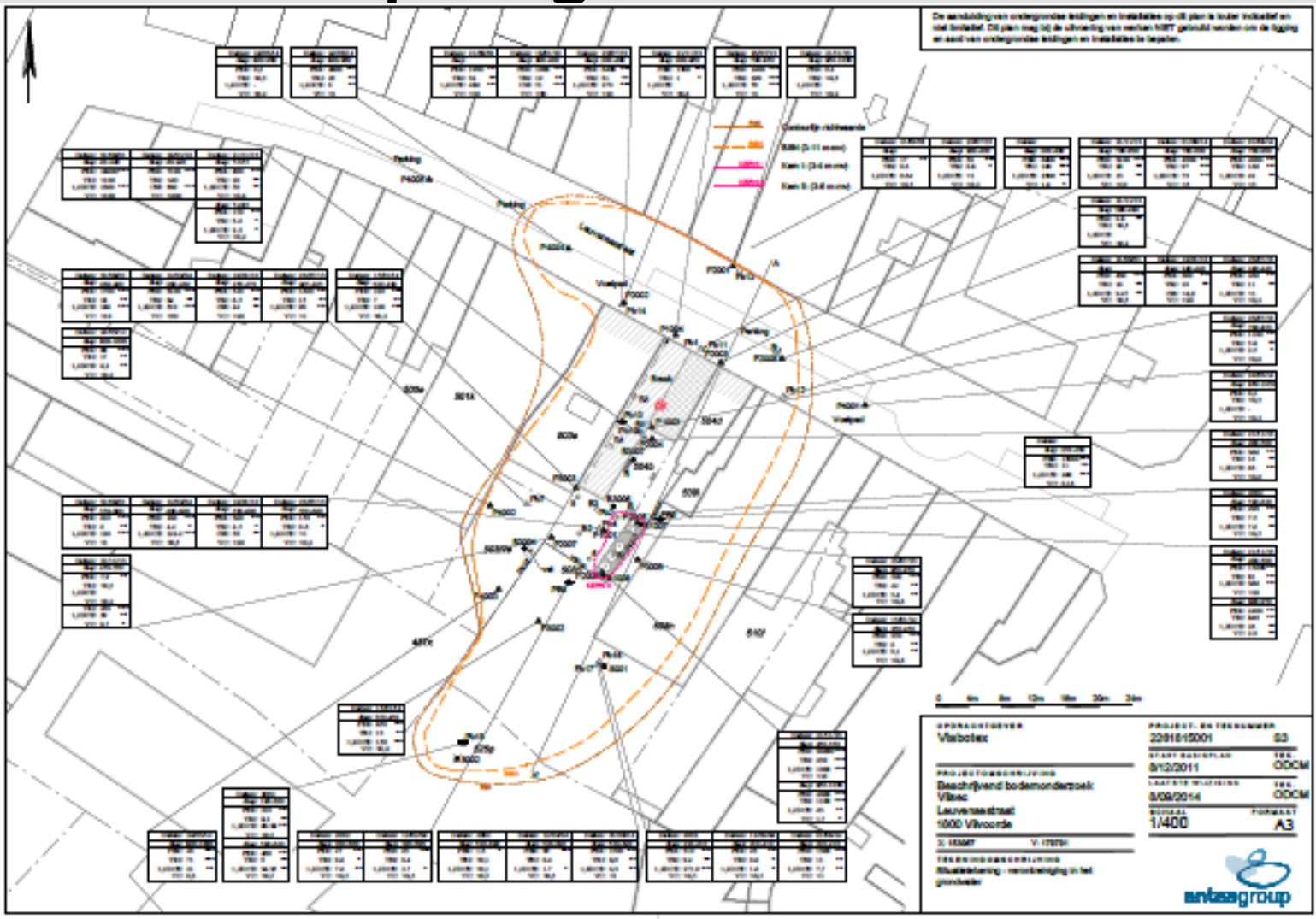
MIP
Membrane Interface Probe



Overview plan ground

fast screening methods

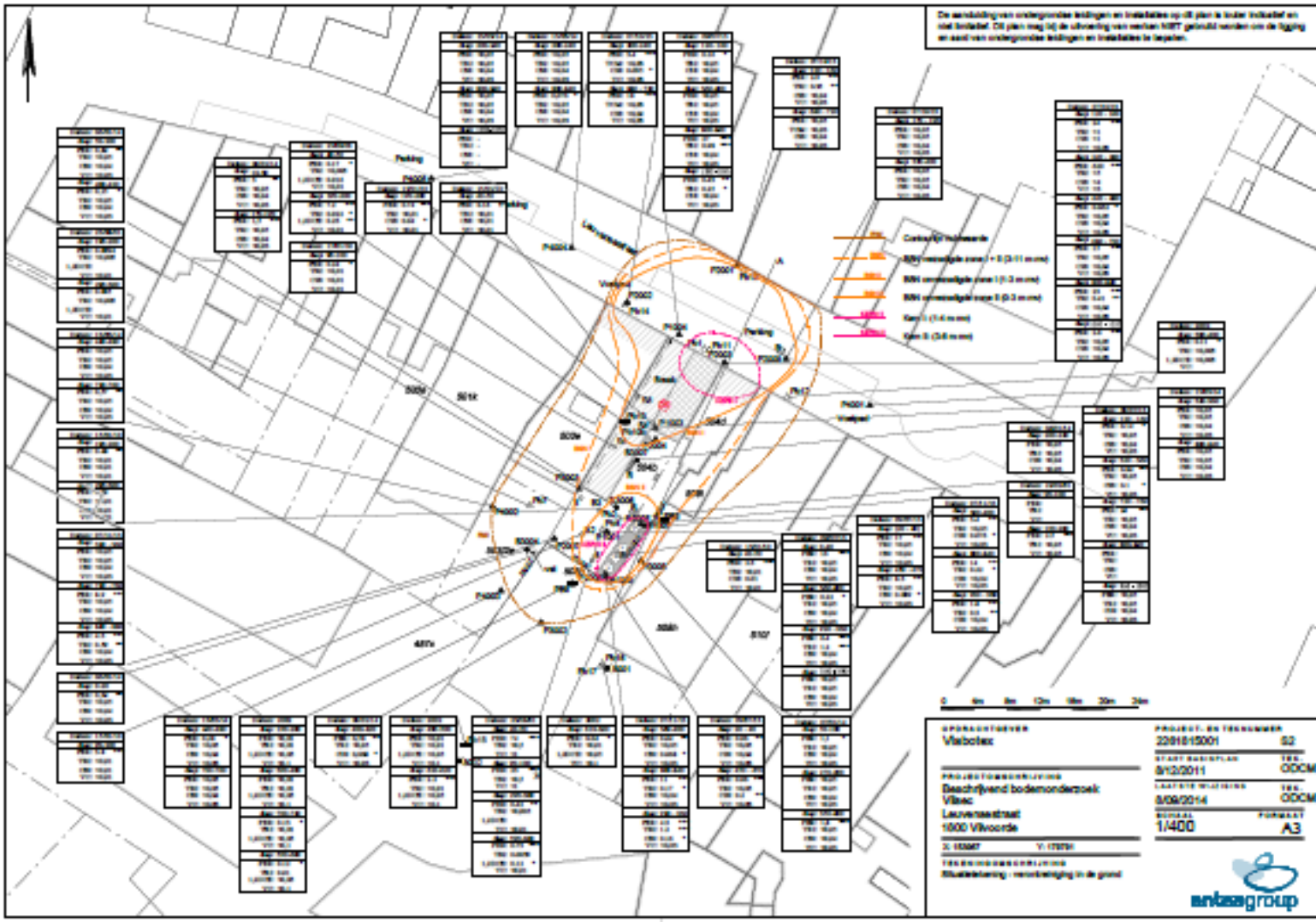
Phased descriptive soil investigation – core zone



Overview plan groundwater

fast screening methods

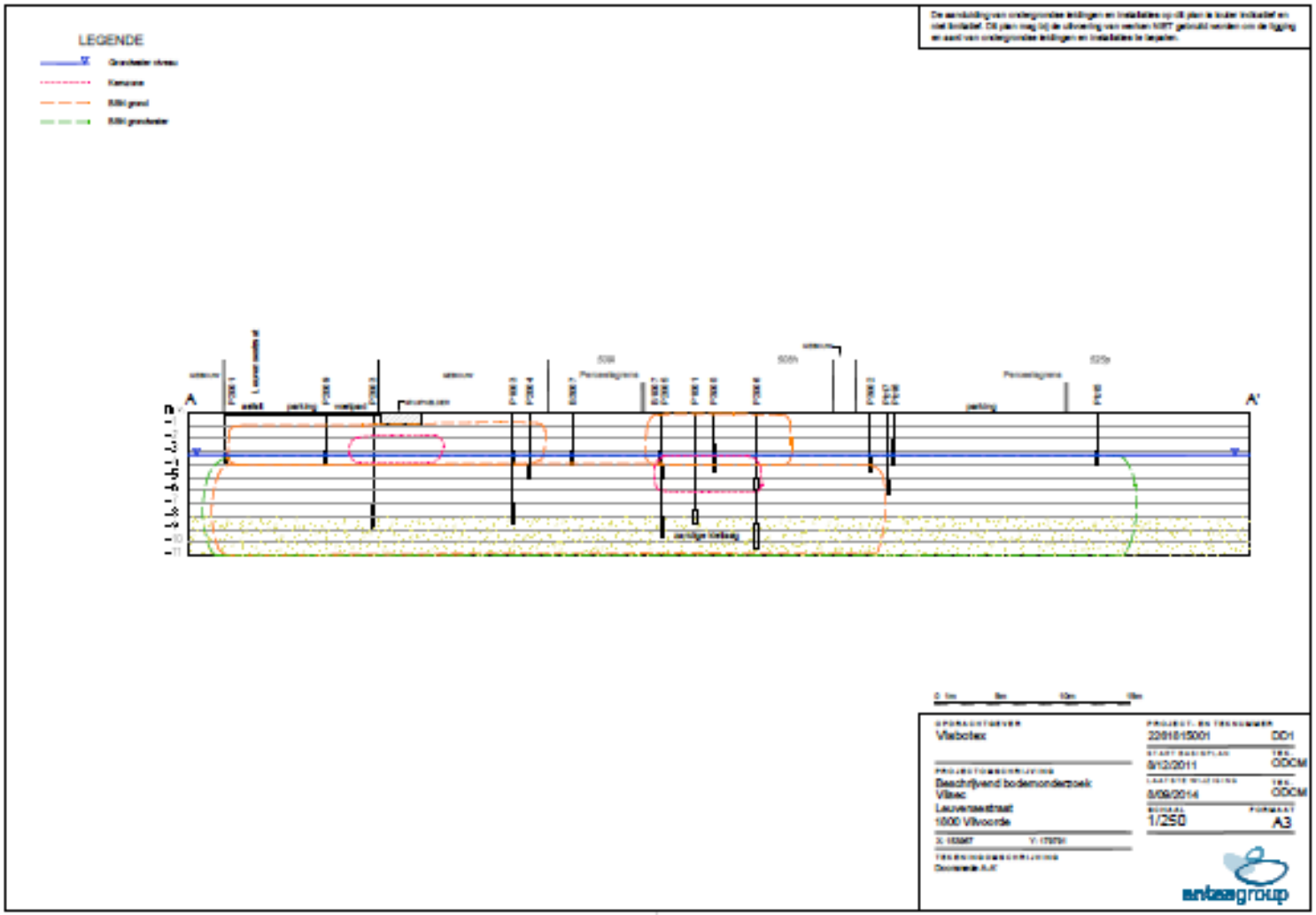
Phased descriptive soil investigation – core zone



Overview plan vertical section

fast screening methods

Phased descriptive soil investigation – core zone



3. Overview procedure

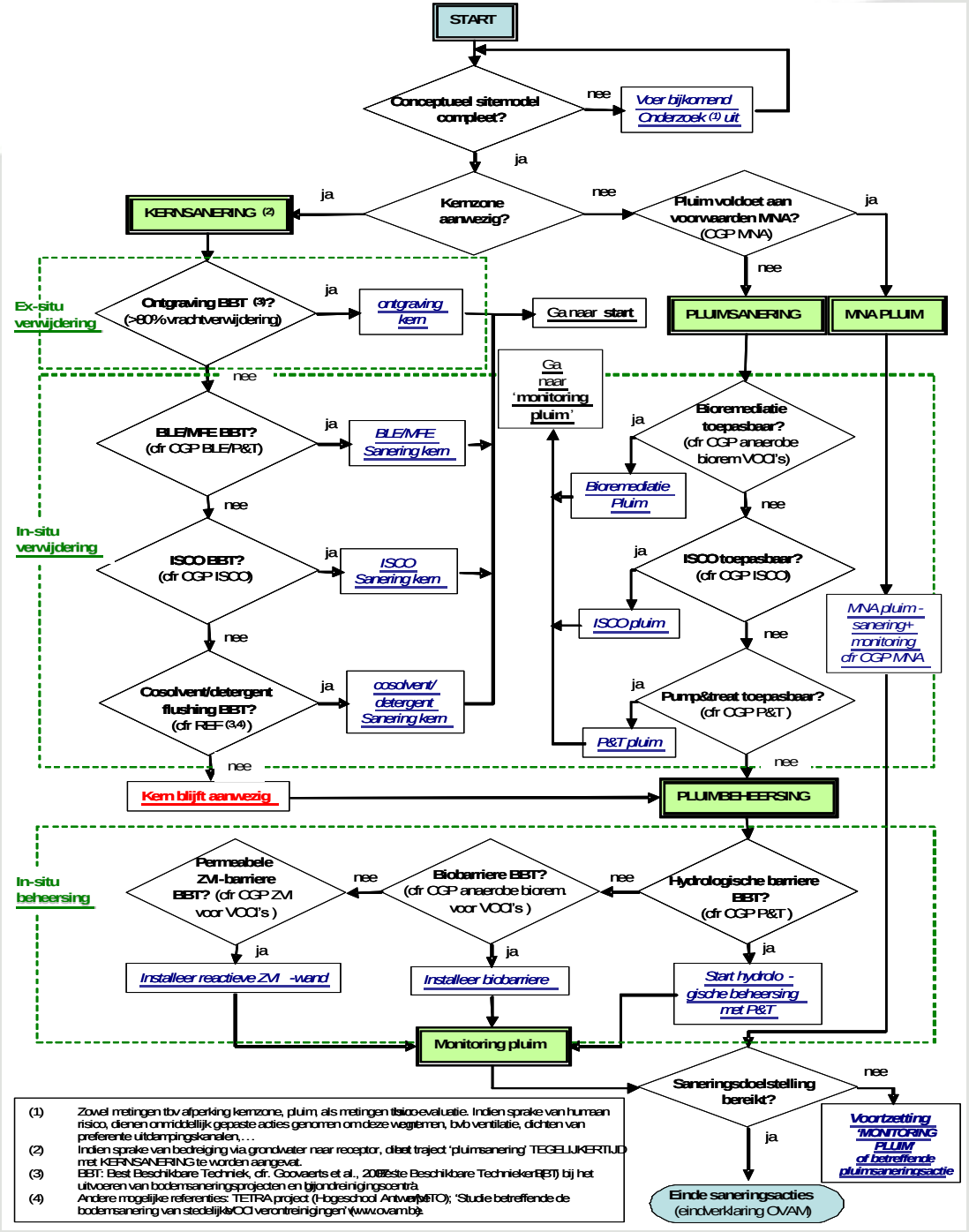
Phased remediation project core zone

Phased remediation project of the core zone

- check whether adequate information for the core zone is available:
  - horizontale and verticale delineation
  - detailed hydrogeological information
- principles of the remediation project
  - bulk of the contamination in core zone
  - core zone is continuous source of contamination plume zone
  - remediation core zone: positive impact on the plume zone!
- best available remediation techniques (BATNEEC)
  - 'proven' clean-up techniques <-> 'more experimental' clean-up technologies
  - flow chart remediation techniques whose feasibility based on site-specific conditions should be screened.

3. Overview procedure

Phased remediation project core zone



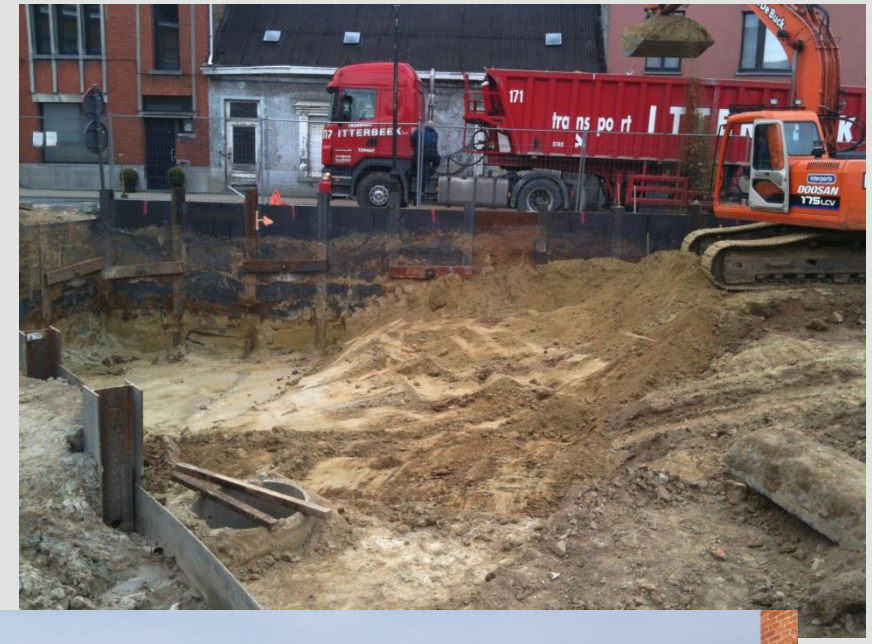
Remediation techniques of the core zone

- Excavation
  - most reliable and fast method
  - preferred remediation technique
  - no or limited risk of failure
  - depth of contamination and presence of infrastructure is the limiting factor
  - costs of stability measures!
  - drainage; treatment costs!
  - integrated remediation approach with site development
    - Basement/underground garage

Excavation technique: Examples of integrated remediation – site Aalst

- Hoeveelheid ontgraving: 965 ton
- Saneringstechniek: ontgraving met beschoeiingsbox + bemaling en zuivering opgepompt grondwater (actief koolfilters)
- Jaar uitvoering werken: 2010
- Na bestemming: gezinswoningen

Excavation technique: Examples of integrated remediation (Lede)



- Hoeveelheid ontgraving: 997 ton
- Jaar uitvoering werken: 2013
- Saneringstechniek: ontgraving met stabiliteitsmaatregelen (damwand)
- Nabestemming: residentie

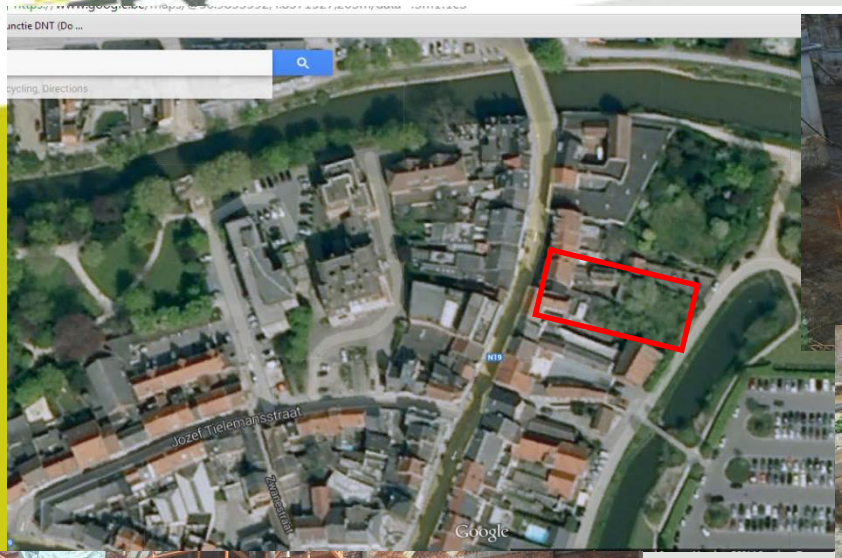
Excavation technique: Ghent

- Hoeveelheid ontgraving: 290 ton
- Periode werken: sept 2014
- Saneringstechniek: inpandige ontgraving in moten (tot 2 m –mv.)
- Na bestemming: gezinswoningen

Excavation technique: Leuven

- Volume ontgraving: 2080 ton
- Periode werken: augustus 2014
- Saneringstechniek: ontgraving met beschoeiingsbox en onder talud en muur verstevigd met schoren
- Nabestemming: verkaveling (woningen, studenten kamers, groenzone…)

Excavation technique: Aarschot



- Hoeveelheid ontgraving: 1398 ton
- Jaar uitvoering werken: 2013-2014
- Saneringstechniek op buurtperceel: ontgraving m.b.v. damwand (onder de fundering bestaande gebouw) met bemaling en zuivering opgepompt grondwater via striptoren en actief koolfilters
- Saneringstechniek in droogkuisatelier: hoogvacuumextractie
- Nabestemming: horecapand met appartementen + verderzetting droogkuisshop

Excavation technique: Wakken

- Volume ontgraving: 1500 ton
- Periode werken: juni 2011
- Saneringstechniek: ontgraving met beschoeiingsbox, onder talud en verbuisde ontgraving + bemaling en zuivering opgepompt grondwater (actief koolfilters)
- Nabestemming: wasserij zonder droogkuis

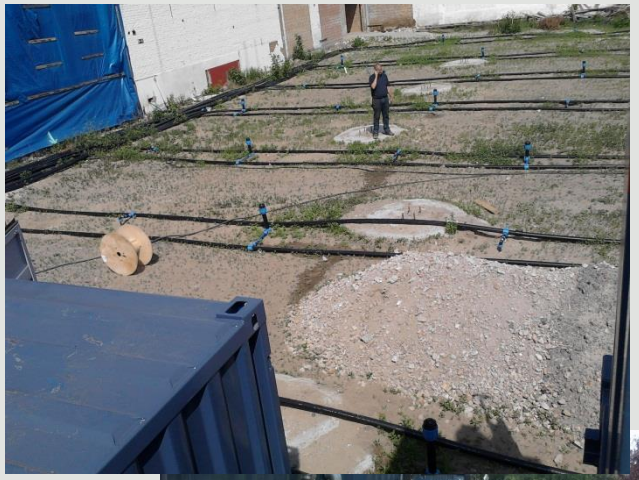
Clean-up techniques core zone

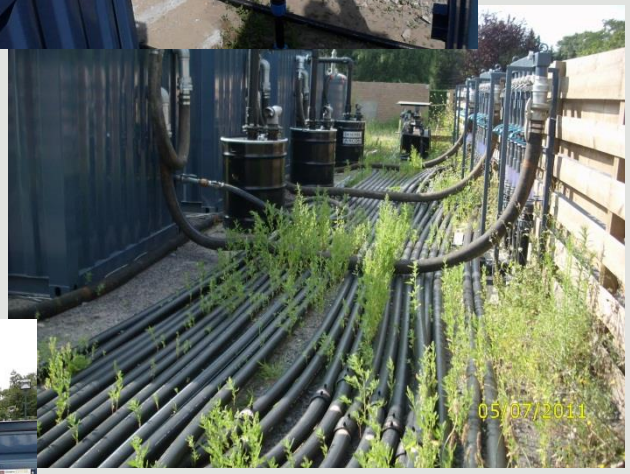
Clean-up techniques core zone (flow chart)

Soil vapor extraction / multi-phase extraction

- extraction soil vapor phase is efficient
- good permeability of the soil
- high energy consumption
- if necessary think about ground water table lowering
- multi-phase extraction in the presence of pure product

Soil vapor extraction / multi-phase extraction: Brugge





- Volume kernzone: 12.110 m3
- Saneringstechniek: in-situ bodemlucht-extractie (BLE) + hoogvacuumextractie (HVE) gevolgd door gestimuleerde biologische afbraak (GBA)
- Aantal BLE filters:43
- Aantal HVE filters:54
- Verwijderde vuilvracht: 1204 kg solvent
- Saneringsperiode: mei 2011- jan 2012 (HVE en BLE) en midden 2012 (injectie melasse als koolstofbron voor GBA)

Soil vapor extraction / multi-phase extraction: Ramsel

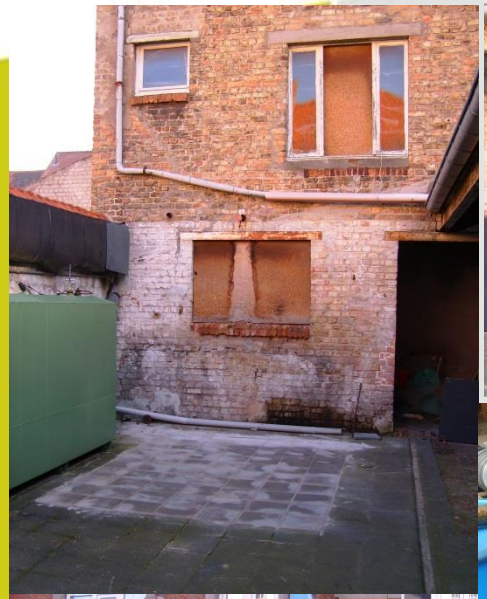
Clean-up techniques core zone

- Volume kernzone: 2,500 m3
- Saneringstechniek: in-situ hoogvacuumextractie (HVE)
- Aantal HVE filters: 35
- Verwijderde vuilvracht: ? kg solvent
- Saneringsperiode: oktober 2014 - ?

Clean-up techniques core zone (flow chart)

- In-situ chemical oxidation
  - laboratory tests (natural oxygen demand)
  - pilot test
  - gas phase ISCO/ liquid phase ISCO
  - limiting factors: soil heterogenity & permeability, NOD, safety

In-situ chemical oxidation: Nieuwpoort



- Saneringstechniek: BLE en ISCO (ozon-injectie) met actief koolfilters (nazuivering)
- Volume kernzone: 752 m3
- Verwijderde vuilvracht via BLE: 65 kg PER
- Periode uitvoering werken: 2013-2014
- Nabestemming: gerenoveerd handelspand

In-situ chemical oxidation: Sint-Denijs-Westrem

Clean-up techniques core zone

- Piloot ISCO (ozon en peroxide-injectie)
- Volume kernzone: 300 m²
- Aantal filters: 10 op 5 m-mv en 10 op 11 m-mv
- Periode uitvoering werken: 2013-2014
- Nabestemming: handelspand

In-situ chemical oxidation: Heusden-zolder

Clean-up techniques core zone

- (ozon en peroxide-injectie)
- Aantal ISCO filters: 22 op 8 m-mv
- Aantal BLE-filters: 10 (1-3,5 m-mv)
- Volume kernzone: 1780 m²
- Periode uitvoering werken: september 2015 - ?

3. Overview procedure

Phased remediation project
core zone

control of the pollution

- if it appears that the in-situ remediation techniques are not BATNEEC

core zone will probably remain, unless a different / new / innovative remediation technology is available

➢ control / monitoring of the pollution is needed.

Phased descriptive soil investigation plume zone

the zone where there is an equilibrium between the pollution in groundwater and the pollution adsorbed to soil particles

targets:

- define the plume zone (contour)
- inventarisation receptors
- risk analysis
- remediation of the plume is necessary?
- monitoring of the plume zone

3. Overview procedure

Phased descriptive soil investigation plume zone

Monitoring

- influence of the remediation of the core zone (and any residual contamination) on the plume zone;
- effect of the remediation of the core zone to potential receptors. Regular measurements (in air monitoring, sampling of pipe or well water, ...) must be provided;
- evaluate the natural degradation of any residual contamination in the core zone and the existing contamination in the plume zone;
- check the potential spread of contamination;
- verifying whether a receptor (drinking water, surface water, water well for irrigation, a private well, ...) in the short or medium term may be affected.

Up to 5 years after the start of the monitoring

an **ultimate decision point** to determine whether remediation of the plume zone is necessary or not.

Remediation techniques in the plume zone:

- natural attenuation

  if no effective receptor threatened + monitored natural attenuation (MNA) is feasible

  ⇩

  MNA is being considered
  Code of good practice OVAM "Natural attenuation"

- enhanced anaerobic bioremediation

  if effective receptor threatened and MNA is not feasible and an active remediation of the plume zone is BATNEEC.
  Back-up variant

  laboratory tests + pilot test

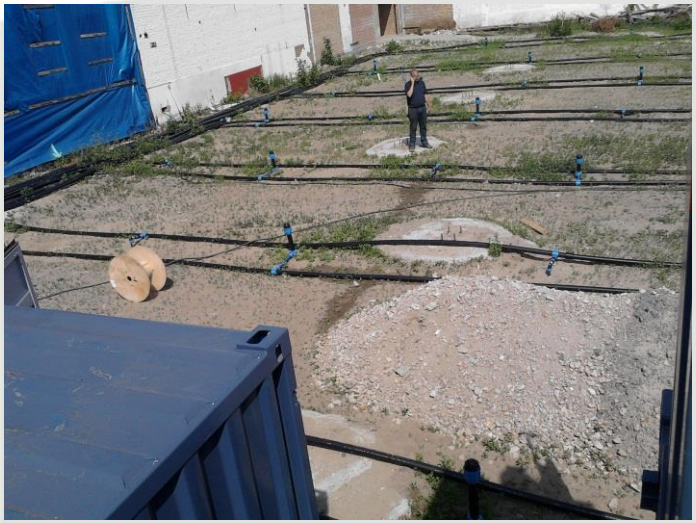
Enhanced anaerobic bioremediation: Eeklo

Clean-up techniques plume zone

Saneringstechniek: gestimuleerde biologische afbraak door direct-push van een langwerkende koolstofbron en zerovalent ijzer (ISCR_EHC)
Volume kernzone: 760 m3
Periode uitvoering werken: 2012 -2014
Nabestemming: appartementsblok met garageboxen

Enhanced anaerobic bioremediation: Brugge

Clean-up techniques plume zone



- Volume kernzone: 12.110 m3
- Saneringstechniek: in-situ bodemlucht-extractie (BLE) + hoogvacuumextractie (HVE) gevolgd door gestimuleerde biologische afbraak (GBA)
- Aantal BLE filters:43
- Aantal HVE filters:54
- Verwijderde vuilvracht: 1204 kg solvent
- Saneringsperiode: mei 2011- jan 2012 (HVE en BLE) en midden 2012 (injectie melasse als koolstofbron voor GBA)
- Nabestemming: kantorencomplex

Enhanced anaerobic bioremediation: Tielt

Clean-up techniques plume zone

- Saneringstechniek: gestimuleerde biologische afbraak door direct push-injecties met een langwerkende koolstofbron (plantaardige olie)
- Volume kernzone: 210 m^3
- Periode uitvoering werken: 2013-2015

Enhanced anaerobic bioremediation: Aalst

- Saneringstechniek: gestimuleerde biologische afbraak via filters (lactaat) na uitgraving
- Injectie lactaat 500 l 10% per filter
- 7 filters tot 2,5-6,5 m-mv en 1 drain op bodem bouwput
- Volume kernzone: 210 m^3
- Periode uitvoering werken: 2015

3. Overview procedure

Phased remediation project Remediations works

Plume zone

- in-situ chemical oxidation
  - laboratory tests
  - pilot test
  - In most cases not BATNEEC
- pump&treat
  - everlasting
  - not suitable as a stand-alone technique
- control of the pollution

  if in-situ remediation techniques are not BATNEEC, the plume zone must be controlled.

  Consultation OVAM is necessary
  - hydrological barrier
  - biological barrier
  - zero valent iron permeable barrier

Thank you for your attention!

4. Questions

Vlabotex npo
www.vlabotex.be
Info@vlabotex.be
+32 56 745 270