

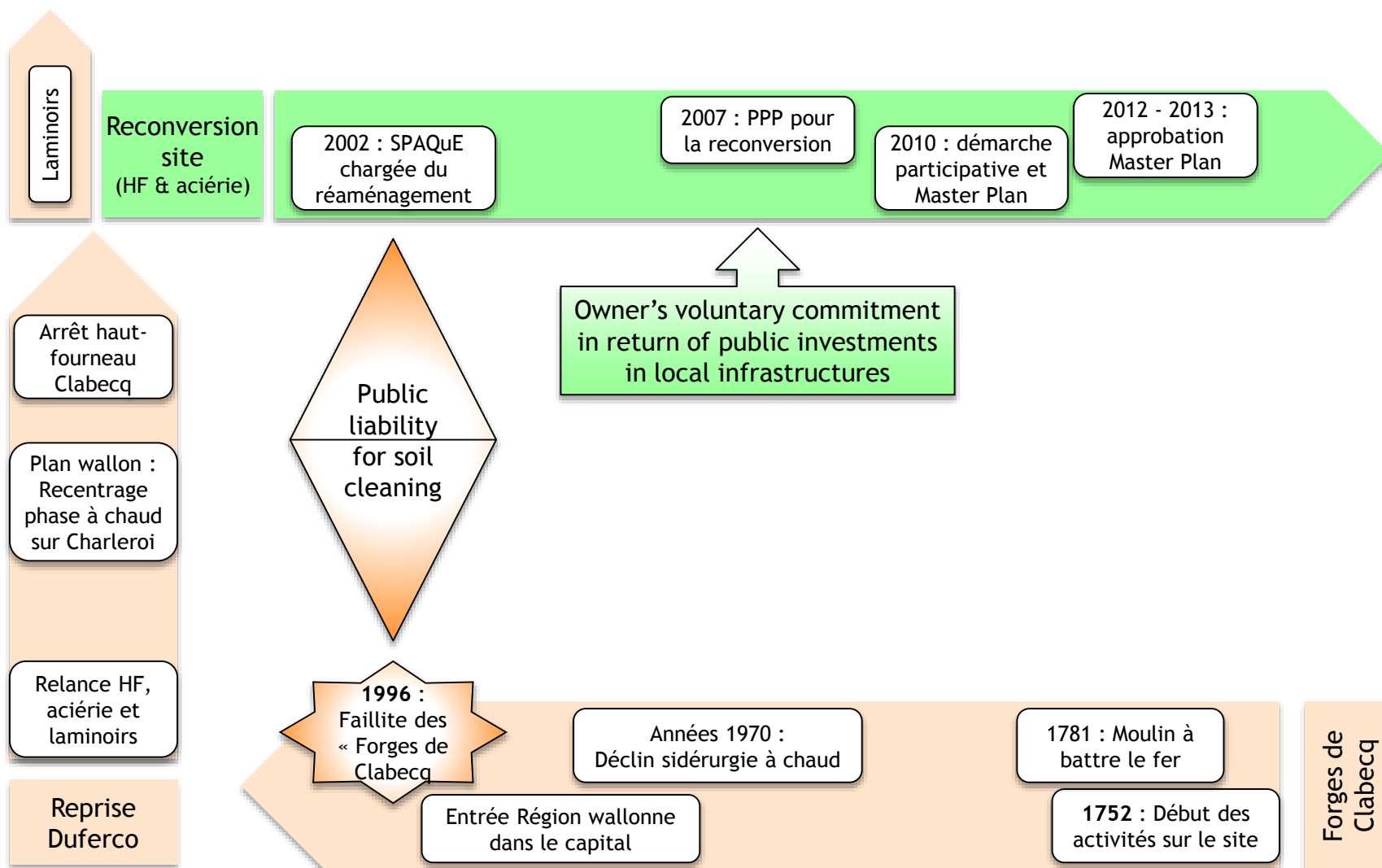
Remediation strategy applied to a major steel industry brownfield
in view of health, environment and land-use considerations



Introduction - presentation of the site - Forges de Clabecq



Historical context



remediation and restoration: main actors

Duferco Wallonie

Duferco GROUP

- Branch of the Duferco Group (steel trading)
- Investor & industrial developer
 - Energy
 - Logistics
 - Environment
- General player in brownfields remediation



- General contractor



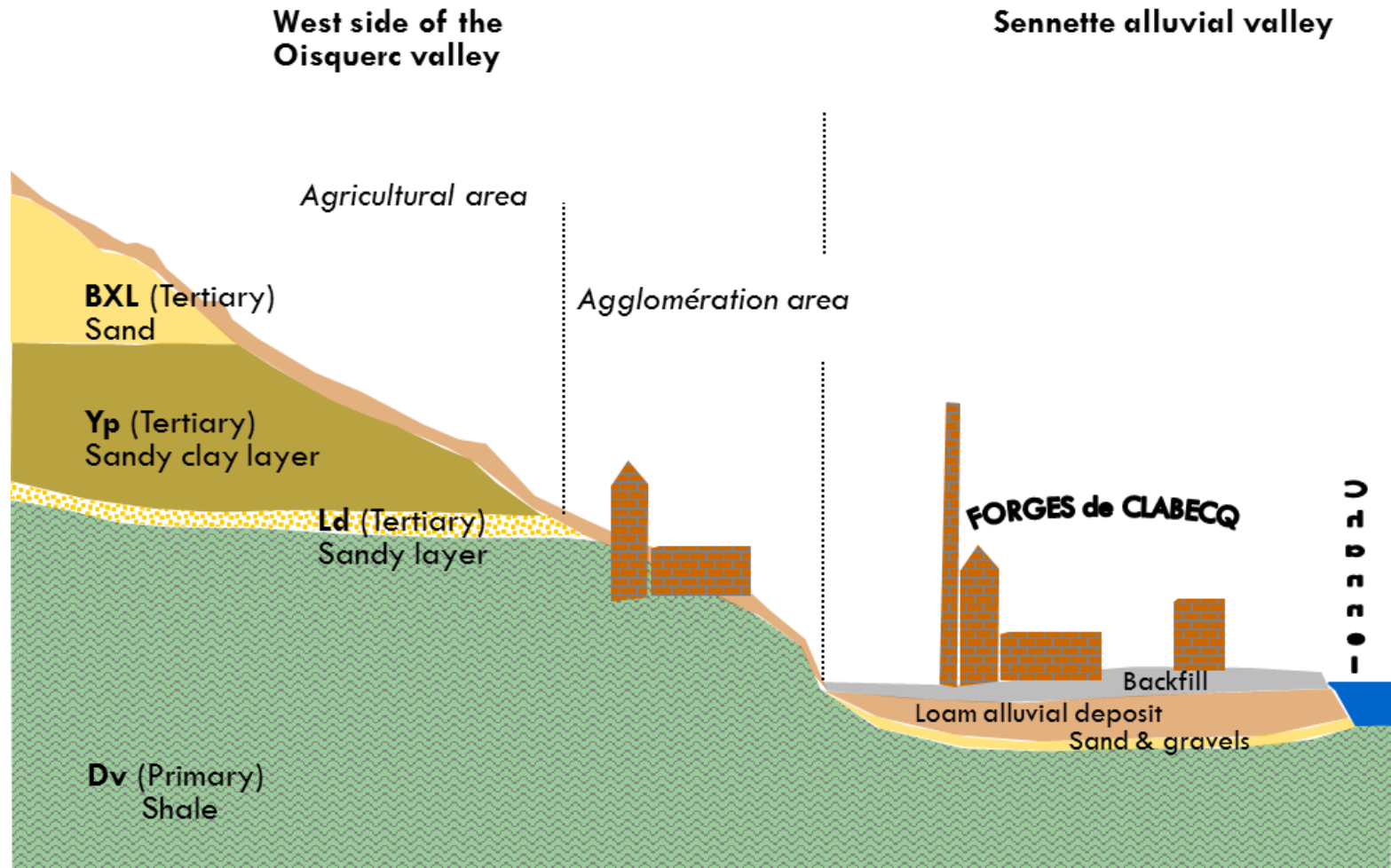
- Affiliated to Duferco Group
- Project management in demolition and soil remediation
- Thermal in situ technology: Thermopile©



- Expert in soil and groundwater remediation
- Authorized expert under Walloon soil regulation

GEOLOGY - HYDROGEOLOGY- HYDROGRAPHY

Know your soil background.. To predict the risks



SOIL SAMPLING STRATEGY



From the historical research to the strategy elaboration process...

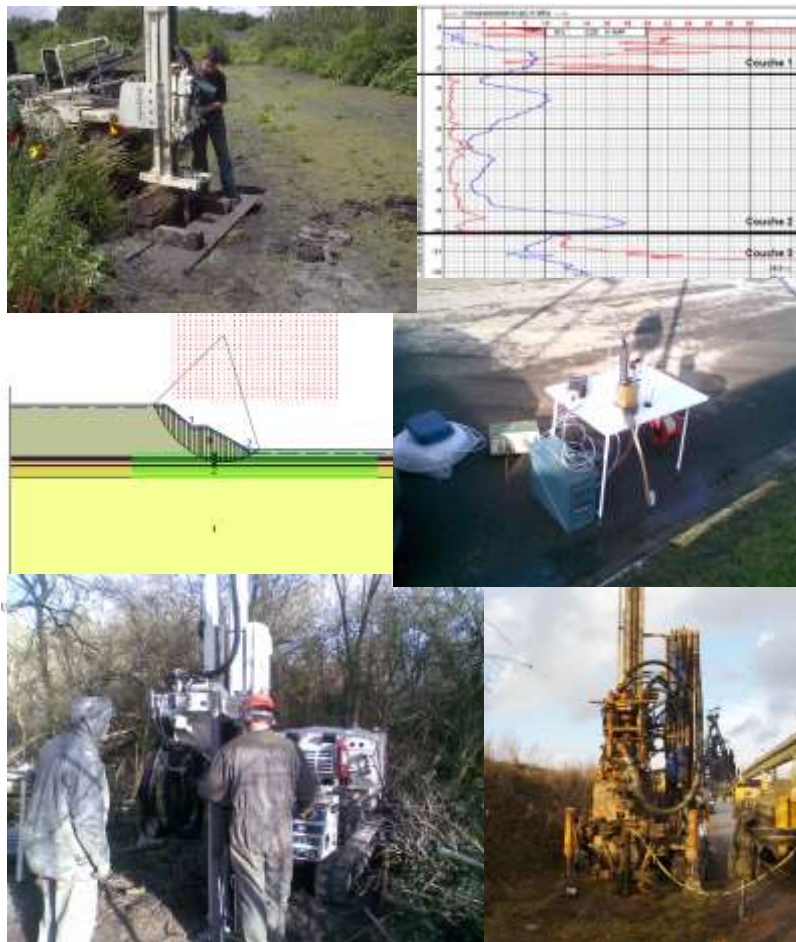
- Environmental Permits, Interview, site visit, old photographs, ...
- Industrial process analysis,
- Risks zones inventory and location,
- Sensitive targets inventory ...

... to prepare and refine the risks analysis



FIELDWORK

... 430 observations, 665 soil samples, 80 piezometers ... to measure the risks analysis useful parameters



Depth of investigation: >20 m

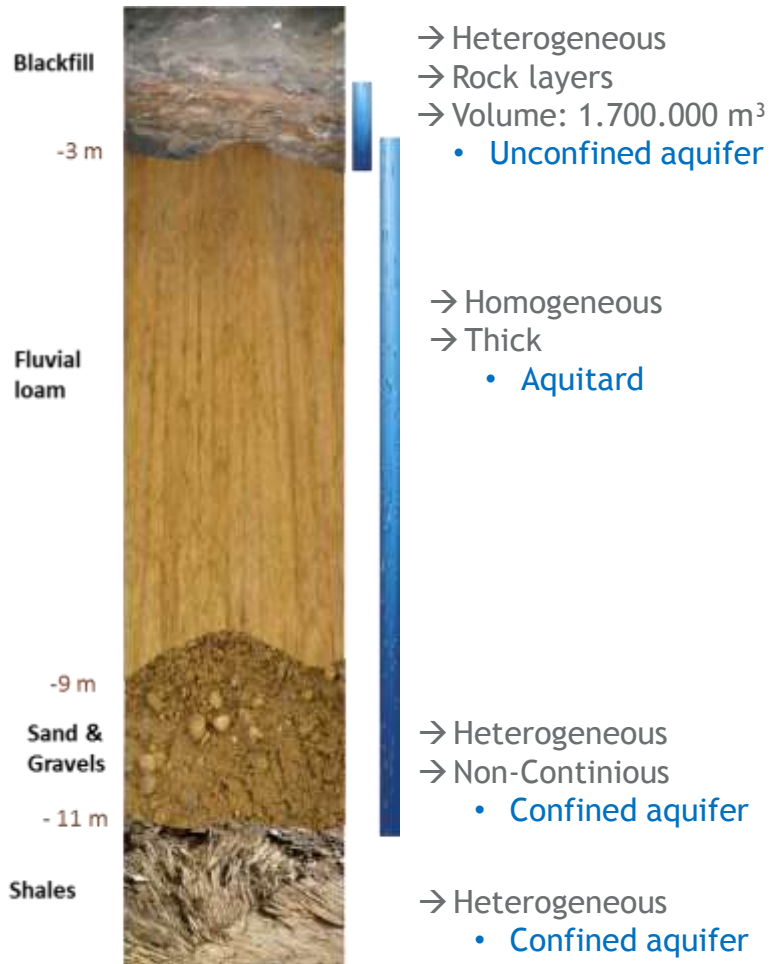
Boring, digs, CPT, ...

Sampling density: square mesh of 30 to 40 m

- Chemical and physical characterisation
- Hydrodynamical processes characterisation
- Geomechanical characterisation

RESULTS : ENVIRONMENTAL MEDIA CHARACTERISATION

Observe and characterize the media ... to conceptualize environmental risk analysis



RESULTS: Interpret ... but how??

Guide Values of the Walloon Soil Decree, December 2008 ... calculated on the risk basis

→ Strong scientific basis internationally recognized (EPA, RBCA, CSOIL, ...)

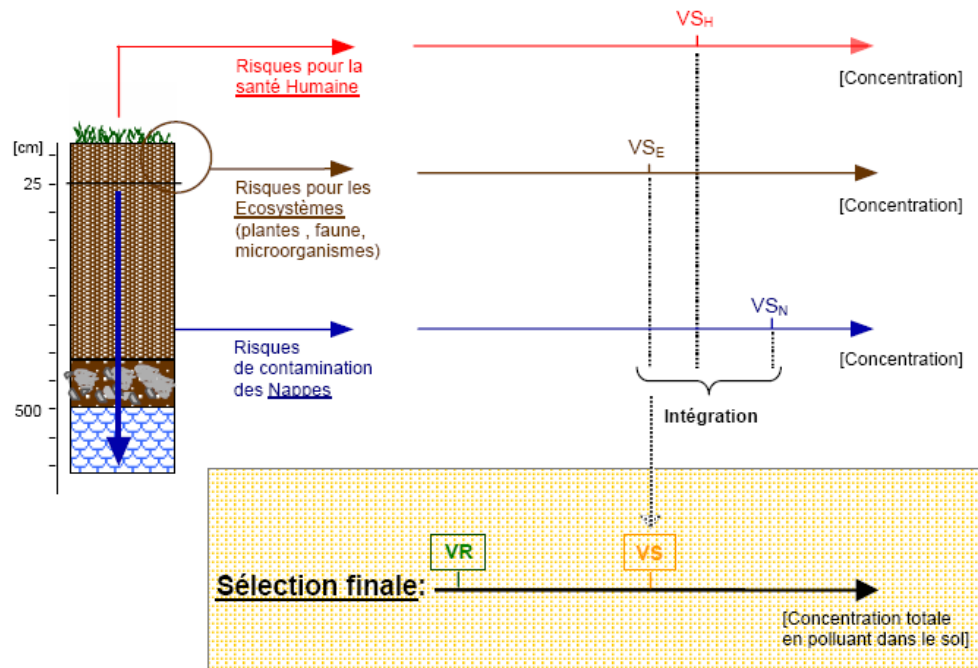
→ 3 Guideline values system

→ Varying according site sensitivity



Historical pollution
Risk evaluation approach

New pollution
Guide values approach



Code Wallon de Bonnes Pratiques, SPW/DGO3

RESULTS: Ground chemical quality (1)

Data management... to select risk analysis parameters



<u>Polluants</u>	<u>Distribution</u>	<u>Contamination</u>
Hydrocarbons, Heavy metals, HAP	Deposit located	Intense
Hydrocarbons, Cyanides	Hot spot	Severe
HAP, Heavy metals	Generalized	Moderate

<u>Polluants</u>	<u>Distribution</u>	<u>Contamination</u>
Huiles minérales	Hot spot	Severe
HAP, ETM, CN	Generalized	Moderate

<u>Polluants</u>	<u>Distribution</u>	<u>Contamination</u>
Huiles minérales, Cyanures	Hot spot	Moderate
HAP, ETM	Generalized	Low

<u>Polluants</u>	<u>Distribution</u>	<u>Contamination</u>
HAP, ETM, Huiles minérales, CN	Generalized	Low

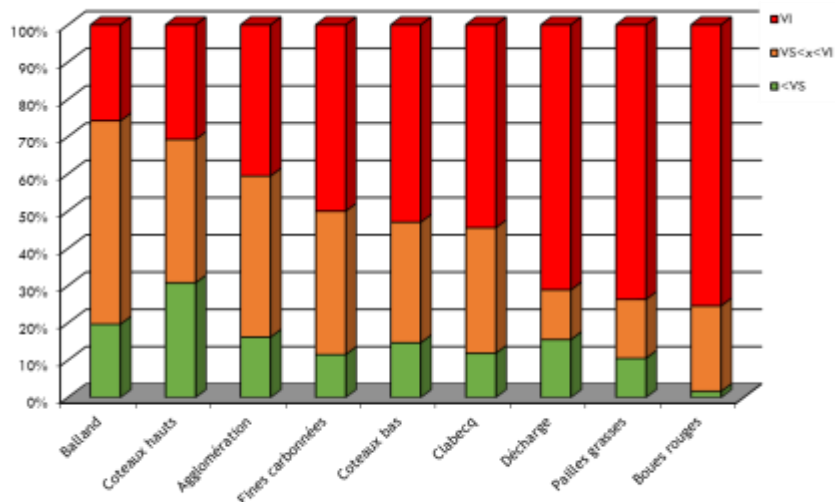
→ General interpretation

- Pollution essentially limited to the backfill materials
- Backfill aquifer globally impacted
- PAHs/Heavy metals non-mobiles (Lixiviation test)
- No volatile pollutants

RESULTS: Ground chemical quality(2)

→ Area-by-area interpretations

- Contamination severity variability by zone



1. Non-contaminated areas
2. Low-level contaminated areas
3. Heterogeneously, sometimes severely, polluted areas
4. Homogeneously severely contaminated areas



RISK ANALYSIS FOR HUMAN HEALTH

Risk modelisation ... to be coherent and avoid WORST CASE Scenarios by data collection improvement

RISK HUMAN Software, developed by par VAN HALL
Institute (Netherlands)
CSOIL and VOLASOIL Equation Based

Inputs

- Actual situation adapted scenario
- Attendance scenario
- Use-based scenario
- Constructive scenario
- Pollutant scenario

→ Pertinent routes of human exposure selection

→ Descriptive pollutant concentrations encryptions



Results analysis

- Risk Index
- Unacceptable results if $RI > 1$

RISK ANALYSIS OPERATION

Exploit risks analysis ... to propose the most suitable solutions to counter the risk

Risk exposure countering

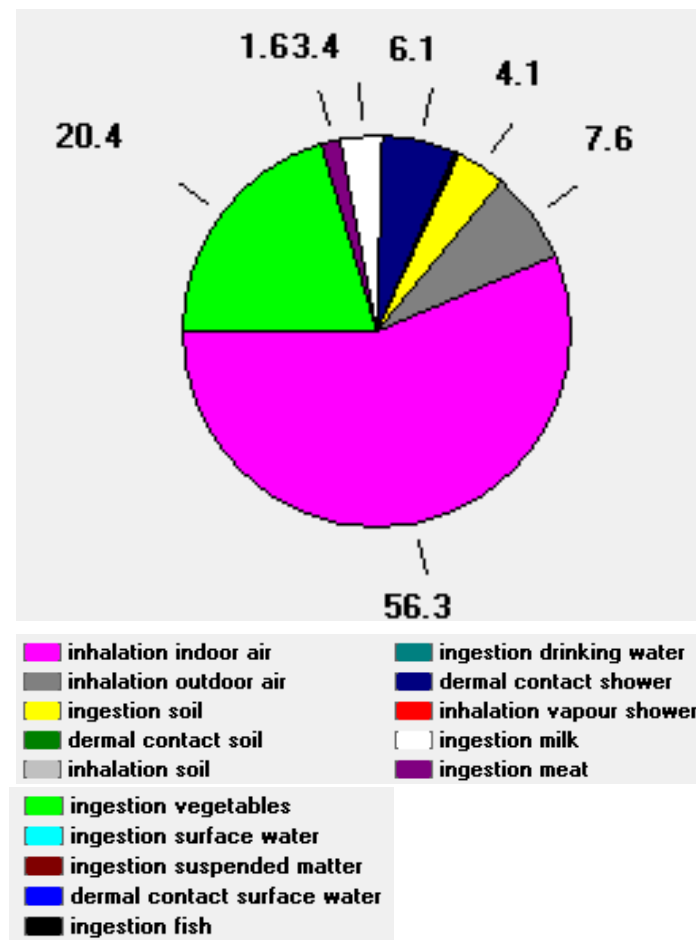
- Limit the pollution severity
- Eliminate exposure route
- Restricted affection

Analysis →
cost/constraints/benefits



Clean-up solutions and safety measures

- Excavation and treatments
- Pump and treat
- Clean soil cover
- Anti-contaminant underground device
- Geomembrane
- Architectural prescriptions
- Restricted access
- ...



GROUNDWATER RISK EVALUATION

Exploit risks analysis ... to propose the most suitable solutions to counter the dispersion

→ Focus on the top aquifer, globally impacted (deeper aquifer is not polluted)

→ Hydraulic confinement groundwater gestion

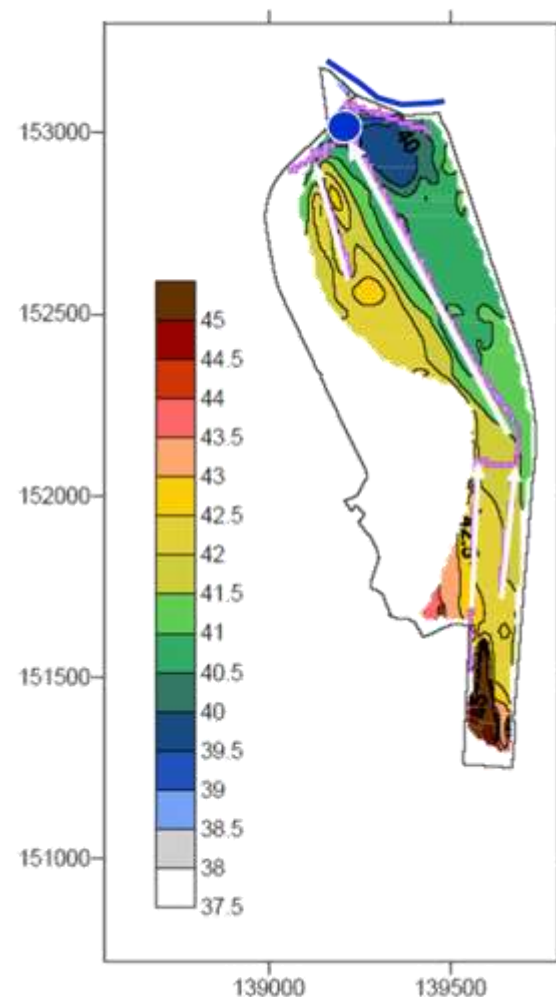
→ Dimensioning method validation

Modelisation tool: MODFLOW

- Flow model
- Transport model
- Trial and error approach

→ Impact on the pollution management visualisation:

- Transport [ni remblais.AVI](#)
- Attenuation [Phe reha.AVI](#)



SITE REHABILITATION

Risks management... to ensure that the site affectation (use, attendance) is suitable with his final quality (Objectives)

Multicriteria analysis

- Quality constraint
- Spatial planning and urban developpement constraint
- Finantial constraint

→ Iterative process

→ Evolutive and participative process

→ Search of the best compromise

→ Elaboration of a potential scale model based on « Who can do more, can do less » principle

→ Freedom

Risk management tools

→ Clean-up

→ Total Volume to treat : 500.000T

→ Guide values

→ Modelisation

→ Safety measure

→ Environmental monitoring

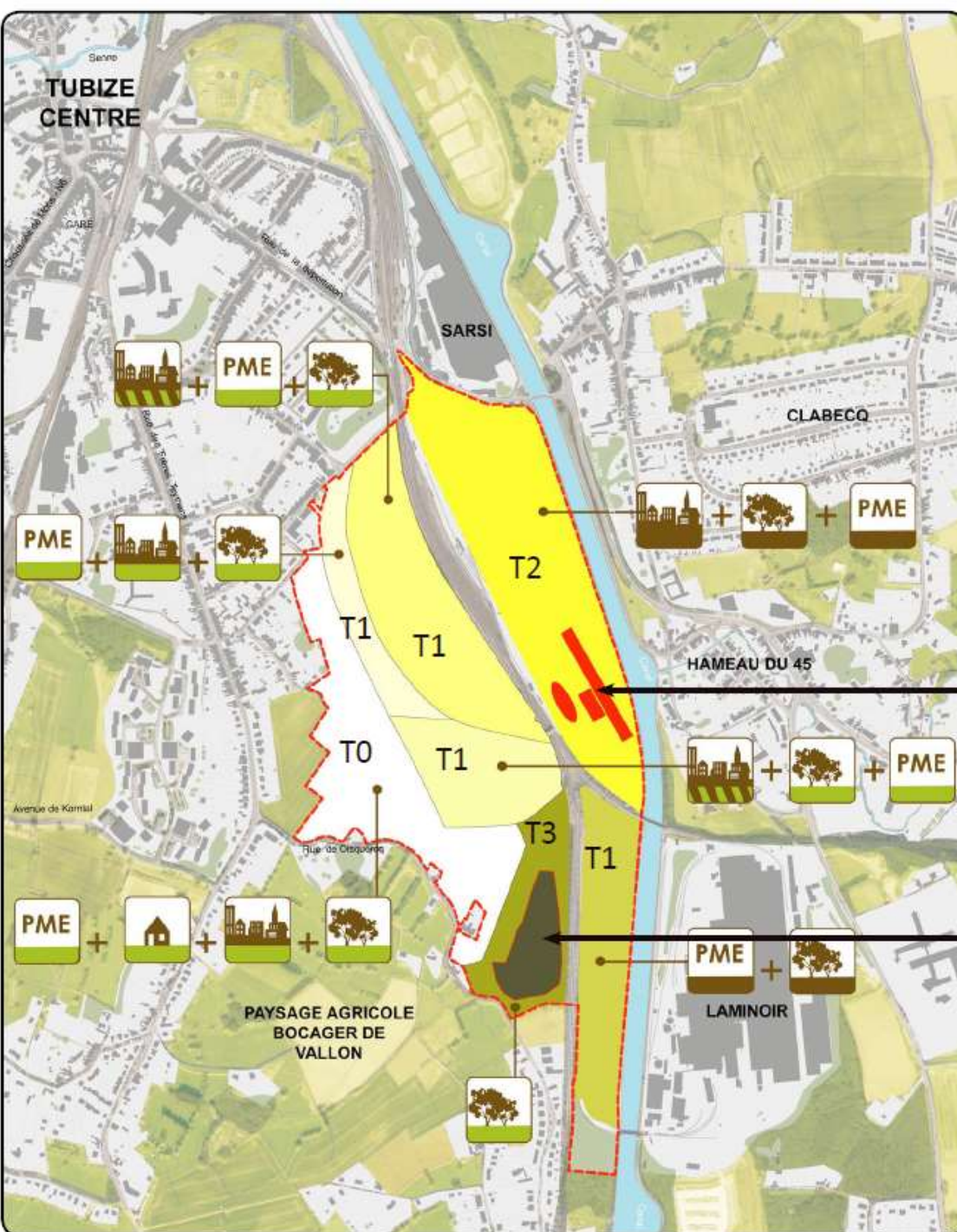
MASTERPLAN - PARTICIPATORY APPROACH

Masterplan - participatory approach



Assainissement

REQUALIFICATION CONDITIONNÉE
PAR L'ASSAINISSEMENT (PRINCIPE DE
PRÉCAUTION): RESTRICTIONS D'USAGES
CROISSANTES.



ORGANISATION DES INSTALLATIONS
D'ASSAINISSEMENT.

ZONE DE CONFINEMENT

- IMPERMÉABILISATION
- RESTRICTIONS D'USAGE
- PAS DE RESTRICTIONS

**REMEDIATION OF THE SITE:
DEMOLITION - RECYCLING - TREATMENT - LANDSCAPE RESTORATION**

Remediation of the site: demolition - recycling - treatment - landscape restoration



REMEDIATION OF THE SITE: EXCAVATION & FILLING

remediation of the site: excavation and filling



remediation of the site: excavation and filling



remediation of the site: excavation and filling



remediation of the site: excavation and filling



remediation of the site: excavation and filling



remediation of the site: excavation and filling



remediation of the site: excavation and filling

- Done at end of February 2016: 500.000 T excavated and backfilled
- To be excavated in total : 785.000 T (500.000 foreseen at the beginning)

REMEDIATION OF THE SITE: PRE-TREATMENT

Remediation of the site: Pre-Treatment



REMEDIATION OF THE SITE: SOIL WASHING

Remediation of the site: Soil Washing

Métaux : 2%

Boues : 25%



Gravier : 35%

Sables : 38%



REMEDIATION OF THE SITE: BIOLOGICAL TREATMENT

Remediation of the site: Biological Treatment



REMEDIATION OF THE SITE: FINAL LAYER

remediation of the site: final layer



remediation of the site: final layer



REMEDIATION OF THE SITE: ENCAPSULATION

remediation of the site: encapsulation



remediation of the site: encapsulation



remediation of the site: encapsulation



remediation of the site: encapsulation



remediation of the site: encapsulation



remediation of the site: encapsulation

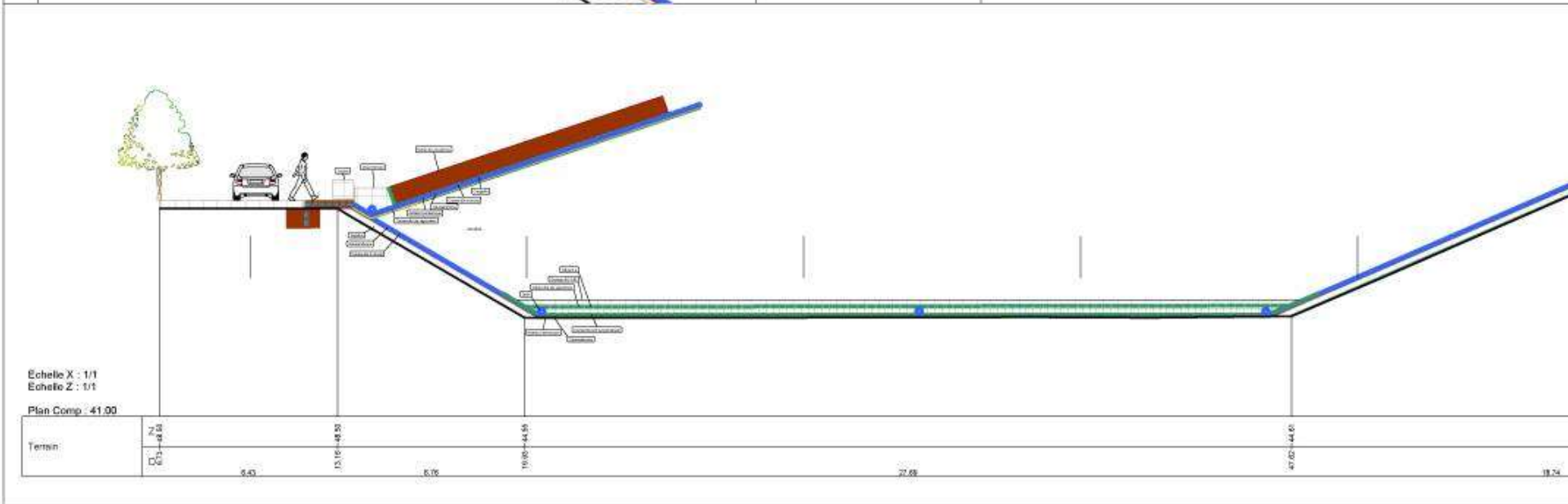
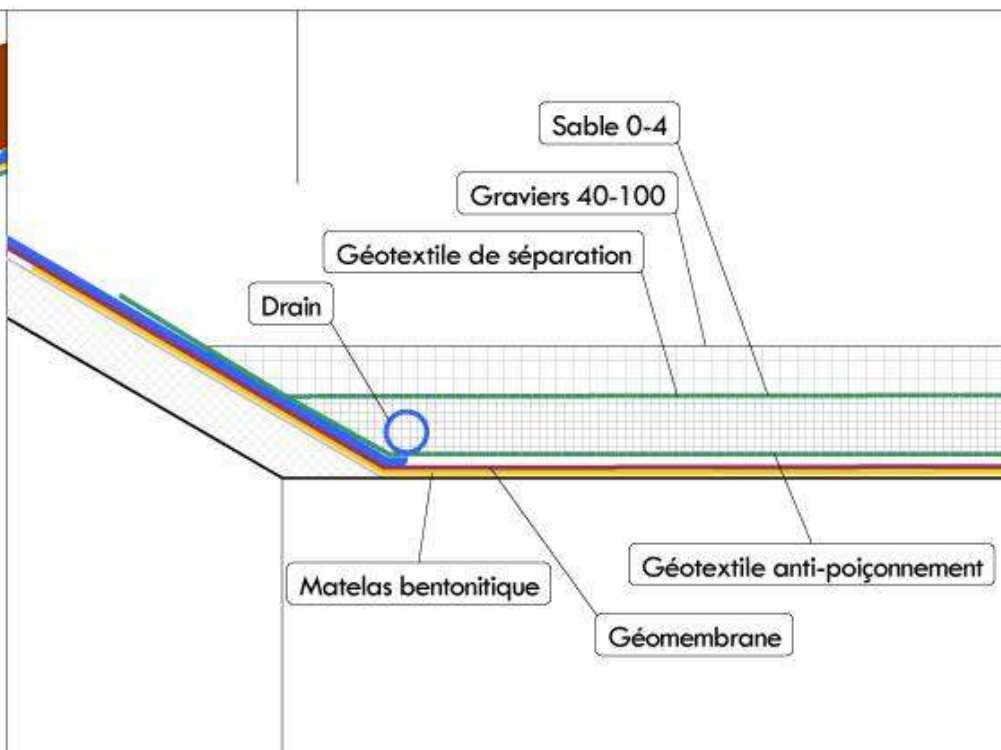
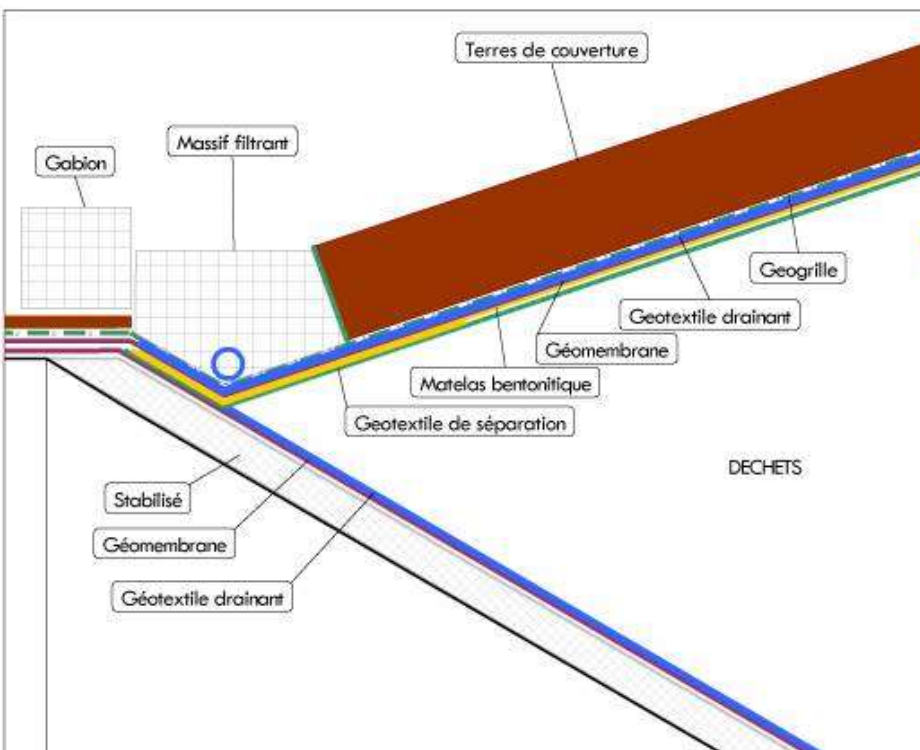


remediation of the site: encapsulation



remediation of the site: encapsulation





remediation of the site: supervision and follow up

- SITEREM
- SECO
- ULG
- GEOTOP
- SGS
- Arcadis
- Geosonda
- Alcontrol
- ...



remediation of the site: communication & adjustment

- Permanent communication with administration allows adjustment to reality
 - thanks to better results than expected on groundwater contamination after soil remediation → watertightness constraint is softened ;
 - flexibility in permit validity: extension possible if works progress.
- Periodic communications with local authorities and citizen representatives: In 3,5 years of remediation works - no complaint from neighborhood



