CEAMaS
Civil Engineering Applications for Marine Sediments

SEDNET CONFERENCE

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Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

MANAGEMENT DECISION PROCESS OF BENEFICIAL REUSE OF MARINE SEDIMENTS IN CIVIL ENGINEERING APPLICATIONS

SUMMARY

- CEAMaS PRESENTATION
- LEGISLATIVE ISSUES
- TECHNICAL ISSUES
- APPLICATIONS

CEAMAS PRESENTATION

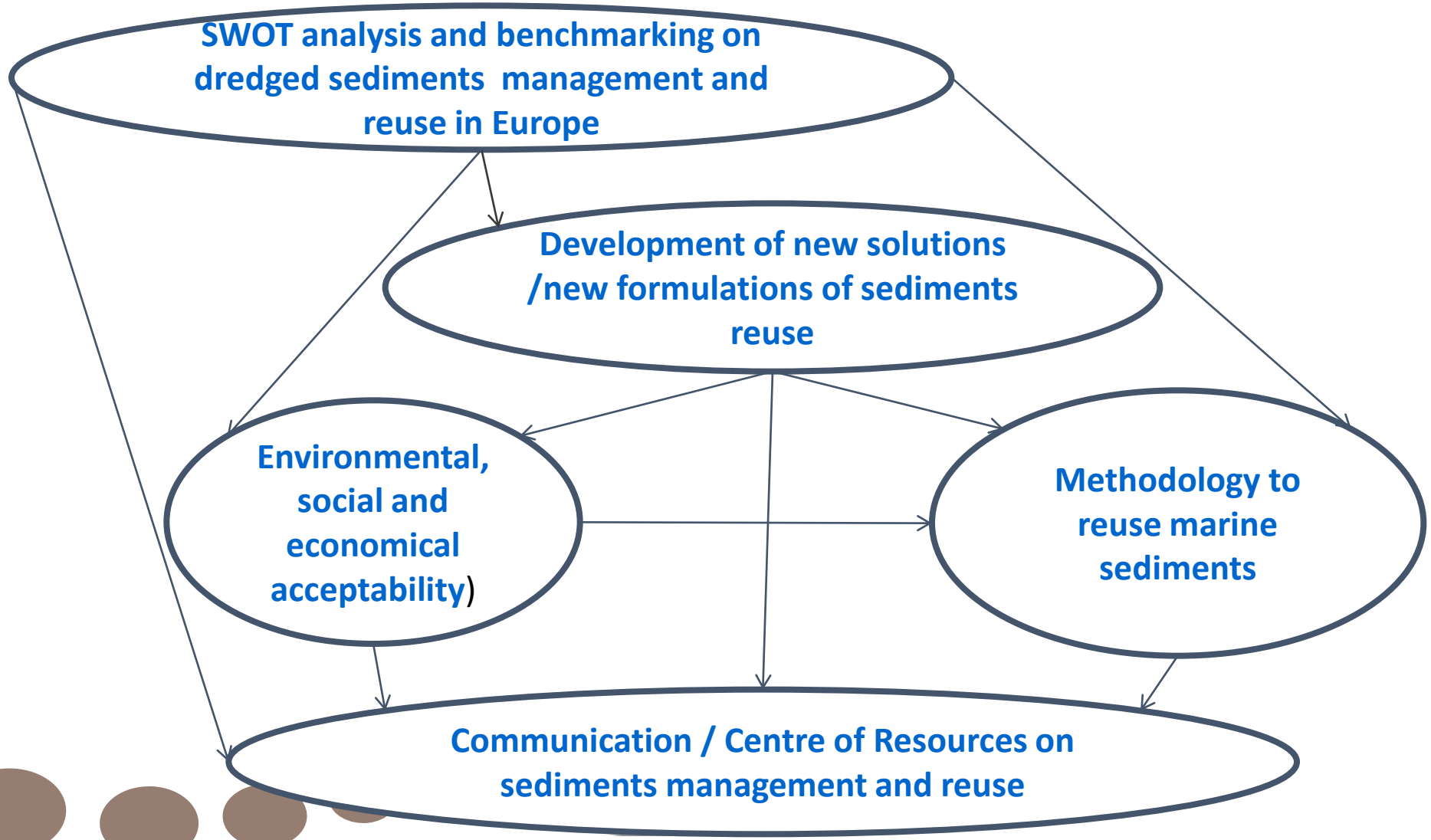
INTERREG IV B PROJECT (2013-2015)

PARTNERS

- **France :**
  - **Cd2e**
  - **BRGM**
  - **Ecole Centrale de Lille**
  - **Université de Lille 1**
- **Ireland:**
  - **University College of Cork**
  - **Cork Institute of Technology**
- **Belgium**
  - **BBRI**
- **Netherlands**
  - **TUDelft / Deltares**

CEAMAS PRESENTATION

5 LINKED WORKPACKAGES



CEAMaS PRESENTATION

WP2 VISION

Raw sediments

Characterization

Legislation ???

Polluted sediments

List of treatment process

Treated sediments

Non Polluted sediments

List of civil engineering applications

List of Raw materials

Formulations

Reuse in civil engineering

LEGISLATIVE ISSUES FOR REUSE

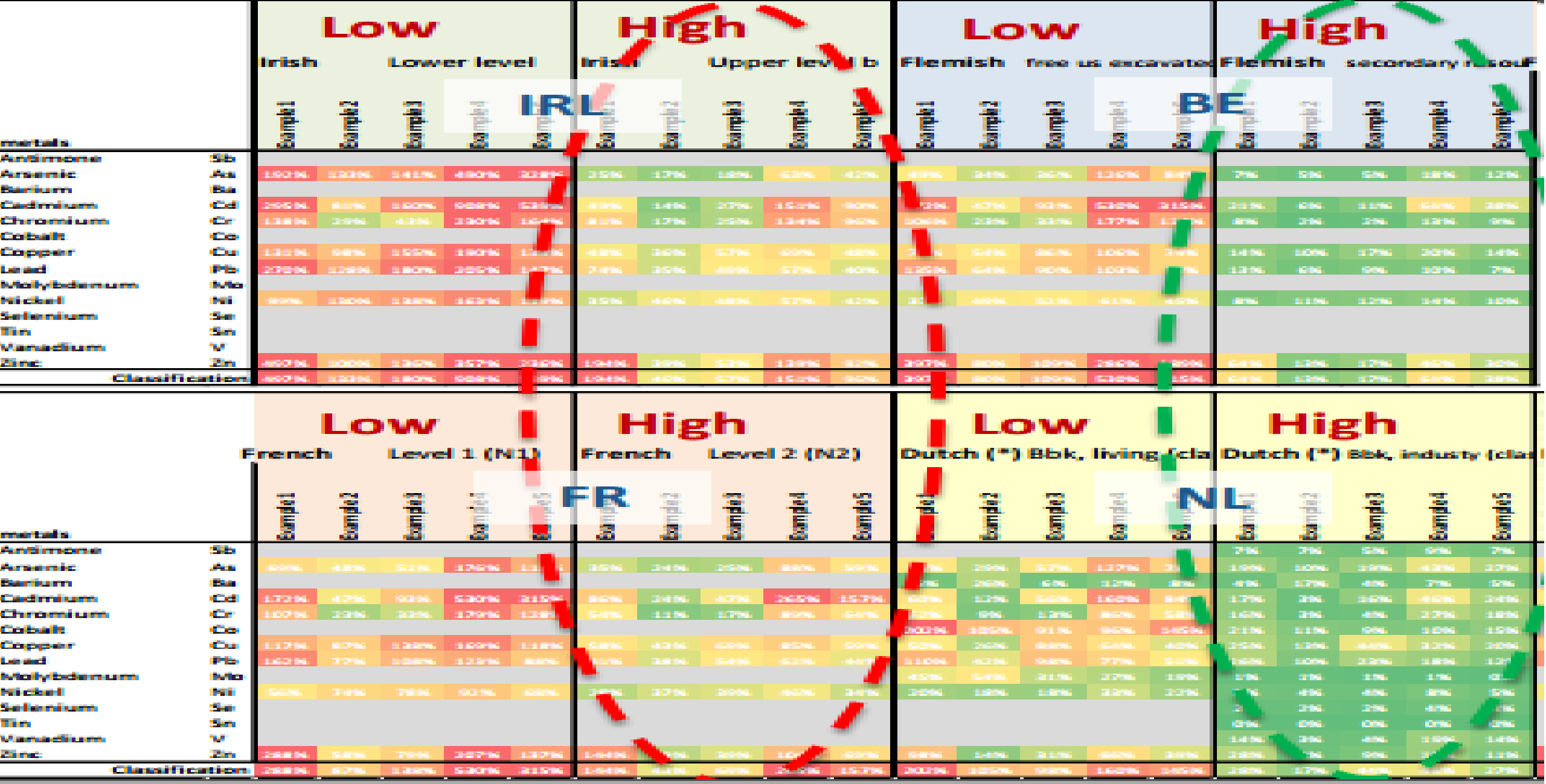
MAJOR CONVENTIONS RELATED TO SEDIMENTS

- OSPAR CONVENTION
- LONDON CONVENTION
- BARCELONA CONVENTION
- HELSINKI CONVENTION

LEGISLATIVE ISSUES FOR REUSE

LEACHING TOOL ACCORDING TO NEN 7373 (2004)

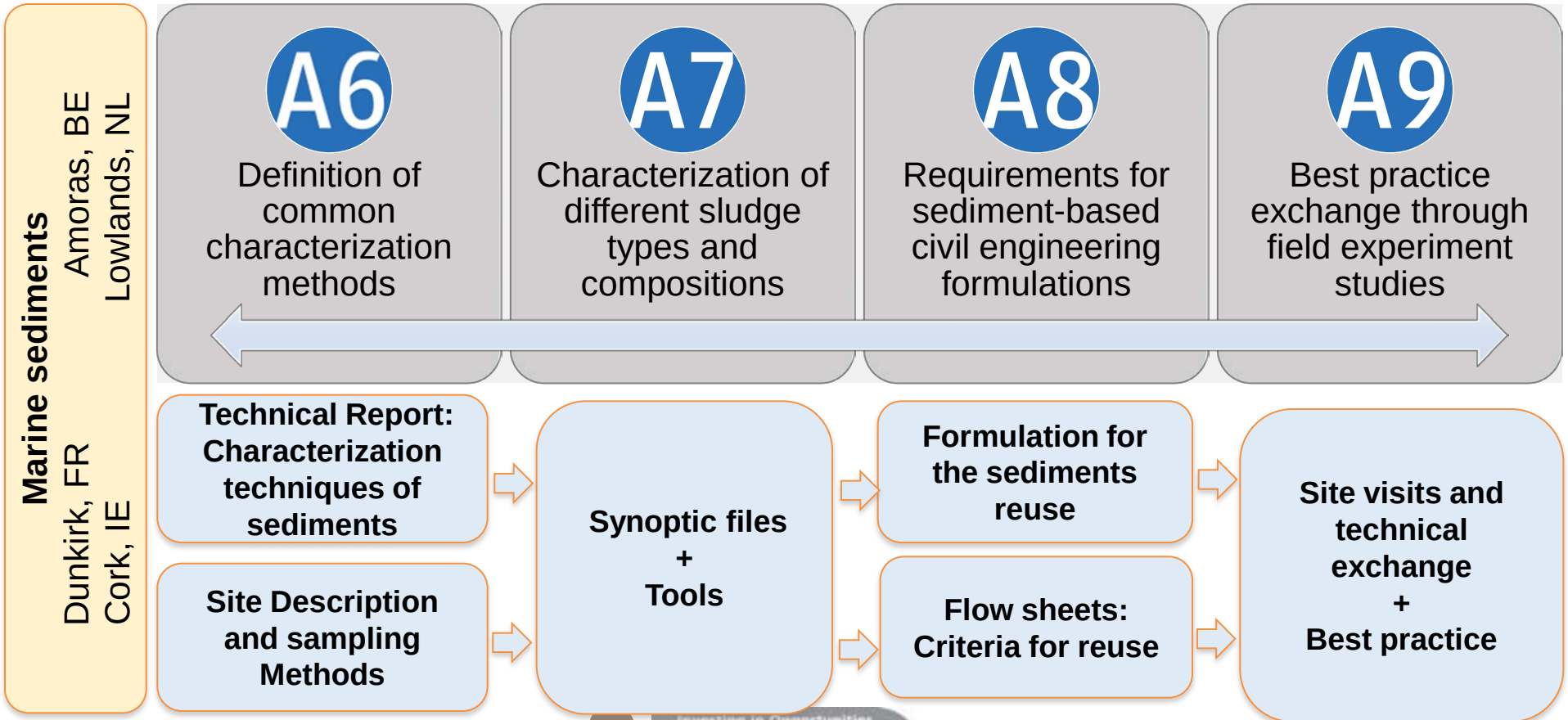
L/S 10		Flemish VLAREA					Dutch NV building material					Dutch IBC building material				
Legislation		Example 1	Example 2	Example 3	Example 4	Example 5	Example 1	Example 2	Example 3	Example 4	Example 5	Example 1	Example 2	Example 3	Example 4	Example 5
metals																
Antimone	Sb						1.2%	0.9%	0.9%	11.4%	1.8%	0.5%	0.4%	0.4%	5.2%	0.8%
Arsenic	As	3.3%	2.2%	2.3%	73.9%	25.6%	3.0%	2.0%	2.0%	65.7%	22.8%	1.3%	0.9%	0.9%	29.6%	10.3%
Barium	Ba						1.0%	0.9%	2.1%	0.9%	0.7%	0.2%	0.2%	0.5%	0.2%	0.1%
Cadmium	Cd	1.2%	2.9%	4.1%	5.5%	5.4%	0.9%	2.2%	3.0%	4.1%	4.0%	0.6%	1.5%	2.0%	2.7%	2.7%
Chromium	Cr	7.1%	7.0%	7.5%	9.0%	9.9%	5.6%	5.6%	5.9%	7.2%	7.8%	0.5%	0.5%	0.5%	0.6%	0.7%
Cobalt	Co						1.4%	2.7%	5.1%	6.8%	3.2%	0.3%	0.6%	1.1%	1.5%	0.7%
Copper	Cu	1.5%	1.5%	1.6%	2.1%	1.1%	0.8%	0.8%	0.9%	1.2%	0.6%	0.1%	0.1%	0.1%	0.1%	0.1%
Mercury	Hg						3.6%	1.9%	1.5%	10.4%	2.1%	0.9%	0.5%	0.4%	2.6%	0.5%
Lead	Pb	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Molybdenum	Mo						1.7%	1.9%	0.6%	24.6%	1.0%	0.1%	0.1%	0.0%	1.6%	0.1%
Nickel	Ni	1.0%	2.7%	7.2%	53.0%	6.5%	1.7%	4.7%	12.2%	90.3%	11.1%	0.4%	1.0%	2.6%	18.9%	2.3%
Selenium	Se						0.1%	0.1%	0.1%	2.7%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%
Tin	Sn						0.3%	0.0%	0.1%	0.1%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%
Vanadium	V						9.8%	7.4%	4.2%	14.7%	6.9%	0.9%	0.7%	0.4%	1.3%	0.6%
Zinc	Zn	4.3%	3.5%	3.5%	3.1%	4.1%	2.6%	2.2%	2.2%	1.9%	2.6%	0.9%	0.7%	0.7%	0.6%	0.8%


Low
Irish Lower level
High
Irish Upper level b
Low
Flemish free us excavate
High
Flemish secondary reuse
IRL
BE
metals
Antimone Sb
Arsenic As
Barium Ba
Cadmium Cd
Chromium Cr
Cobalt Co
Copper Cu
Lead Pb
Molybdenum Mo
Nickel Ni
Selenium Se
Tin Sn
Vanadium V
Zinc Zn
Classification
Low
French Level 1 (N1)
High
French Level 2 (N2)
Low
Dutch (*) Bbk, living (cla
High
Dutch (*) Bbk, industy (cla
FR
NL
metals
Antimone Sb
Arsenic As
Barium Ba
Cadmium Cd
Chromium Cr
Cobalt Co
Copper Cu
Lead Pb
Molybdenum Mo
Nickel Ni
Selenium Se
Tin Sn
Vanadium V
Zinc Zn
Classification

TECHNICAL ISSUES FOR REUSE

ACIONS IN WP2

WP2 - Development of new solutions /new formulations of sediments reuse



TECHNICAL ISSUES FOR REUSE

SEDIMENT CHARACTERISATION TECHNICS FOR REUSE

METHODOLOGY

A6 - PHYSICAL, GEOTECHNICAL, AND CHEMICAL CHARACTERIZATION TECHNIQUES OF SEDIMENTS

Netherlands — France — Ireland

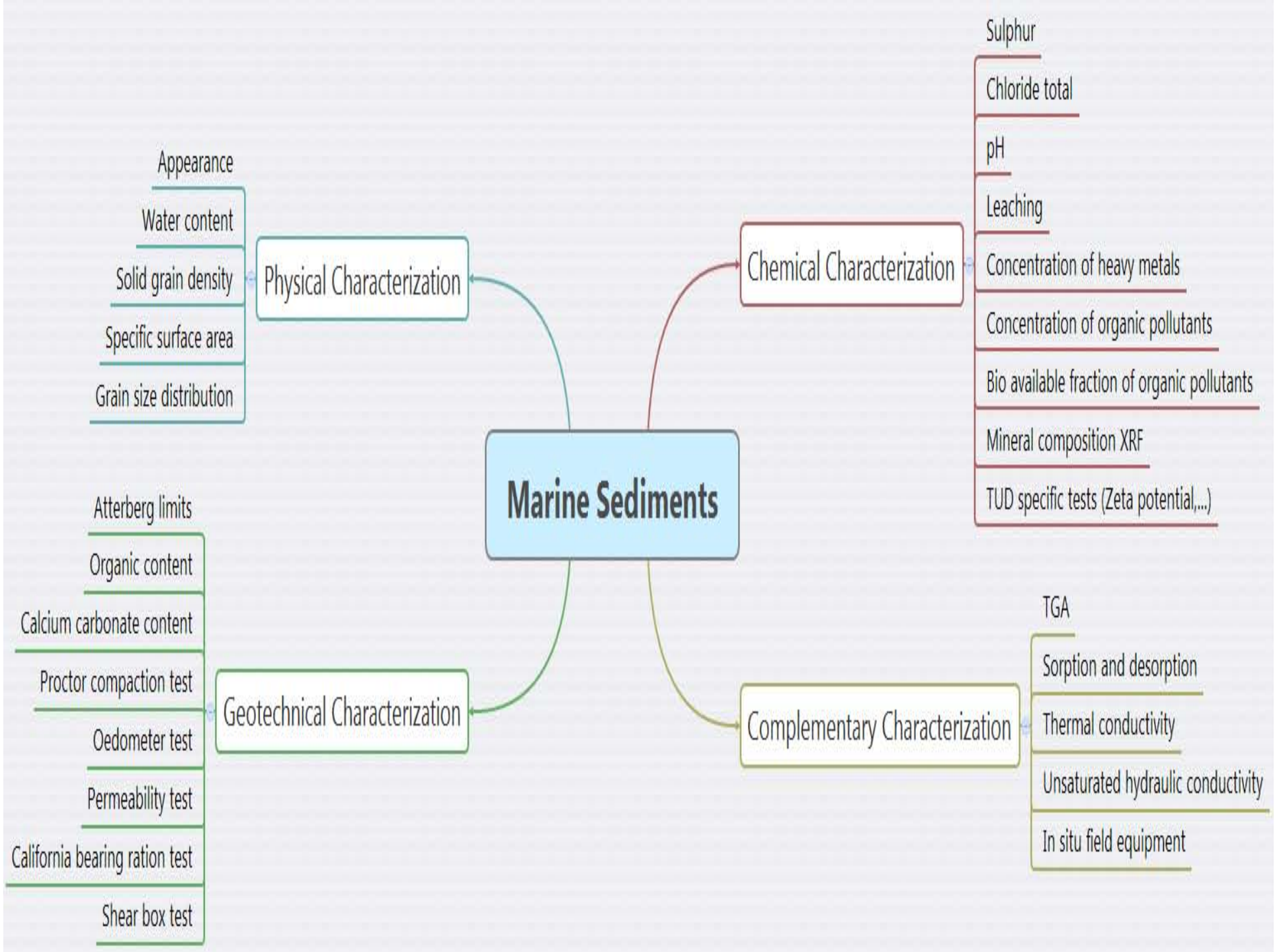
Site Description and sampling Methods



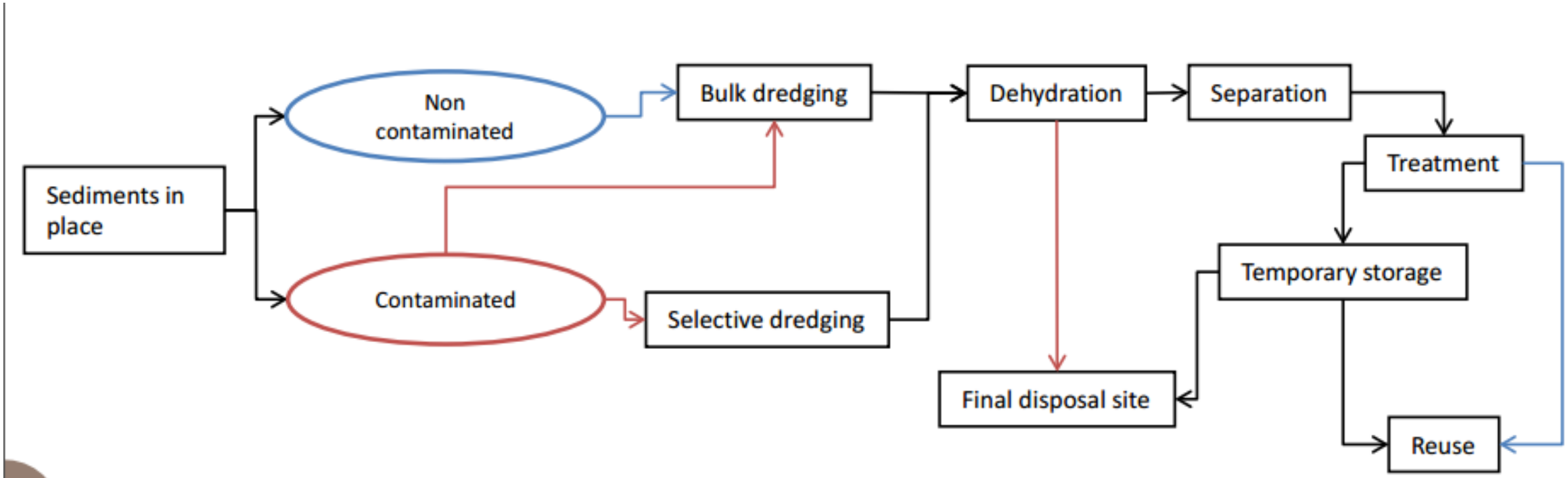

A7- CHARACTERIZATION OF SEDIMENTS

Synoptic file for each studied sediment + Classification

A8- Requirements for sediment-based civil engineering formulations


Marine Sediments
Physical Characterization
Appearance
Water content
Solid grain density
Specific surface area
Grain size distribution
Chemical Characterization
Sulphur
Chloride total
pH
Leaching
Concentration of heavy metals
Concentration of organic pollutants
Bio available fraction of organic pollutants
Mineral composition XRF
TUD specific tests (Zeta potential,...)
Geotechnical Characterization
Atterberg limits
Organic content
Calcium carbonate content
Proctor compaction test
Oedometer test
Permeability test
California bearing ration test
Shear box test
Complementary Characterization
TGA
Sorption and desorption
Thermal conductivity
Unsaturated hydraulic conductivity
In situ field equipment

TECHNICAL ISSUES FOR REUSE



TECHNICAL ISSUES FOR REUSE

EC LILLE

Physical, Geotechnical and Complementary characterization

Density	Organic content
Water content	Proctor Compaction test
Grain Size Distribution	Consolidation test
Atterberg limits	Permeability
Methylene blue adsorption	TGA
Specific surface area	Sorption & Desorption
Calcium carbonate content	Thermal Conductivity

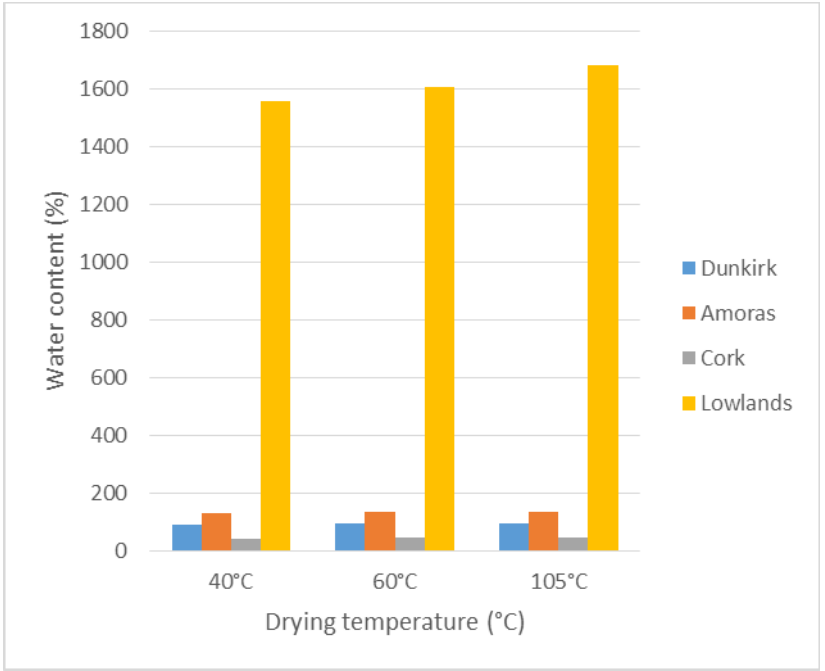
TECHNICAL ISSUES FOR REUSE

EC LILLE

PHYSICAL TESTS RESULTS

Water content in the raw sediments (NF P94-050)

	40˚C	60˚C	105˚C
Dunkirk	92,58	93,78	95,5
Amoras	132,84	134,54	136,5
Cork	44,15	44,5	45,05
Lowlands	1555,4	1606,86	1683,35

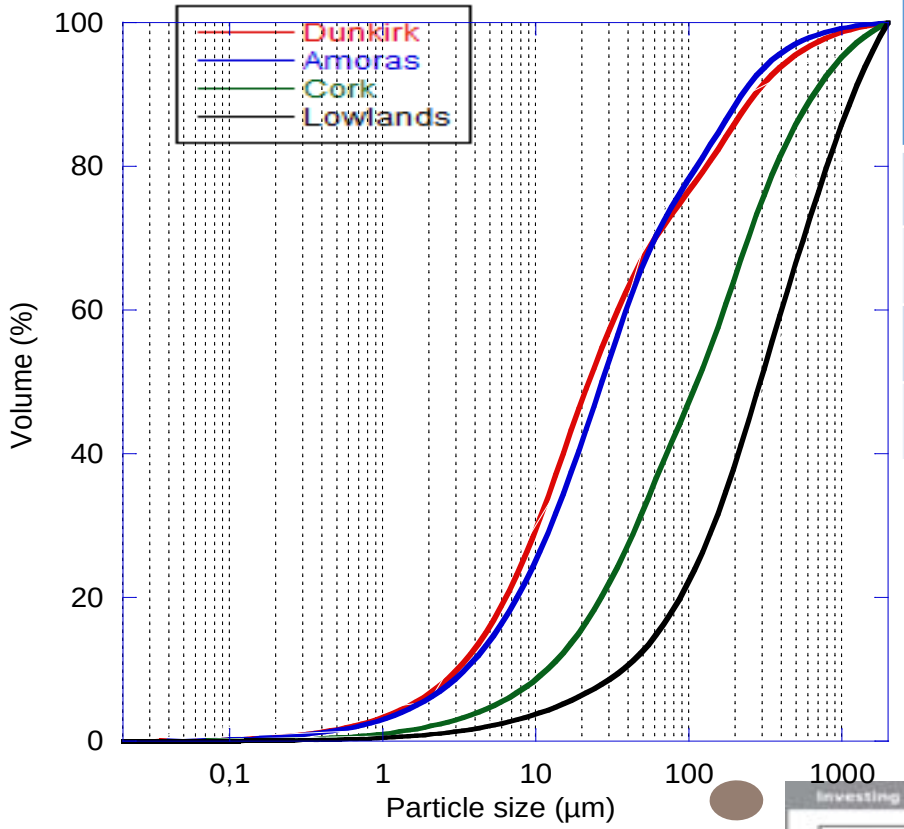


TECHNICAL ISSUES FOR REUSE

EC LILLE

PHYSICAL TESTS RESULTS

Particle size distribution (by laser granulometry: Malvern Mastersizer 2000)



Granular fractions (NF EN ISO 14688-1)	Clay (< 2 µm)	Silt (between 2 µm and 63 µm)	Sand (between 63 µm and 2000 µm)
Dunkirk	6,03	65,53	28,43
Amoras	5,48	67,41	27,11
Cork	1,89	36,33	61,79
Lowlands	0,85	13,29	85,86

TECHNICAL ISSUES FOR REUSE

EC LILLE

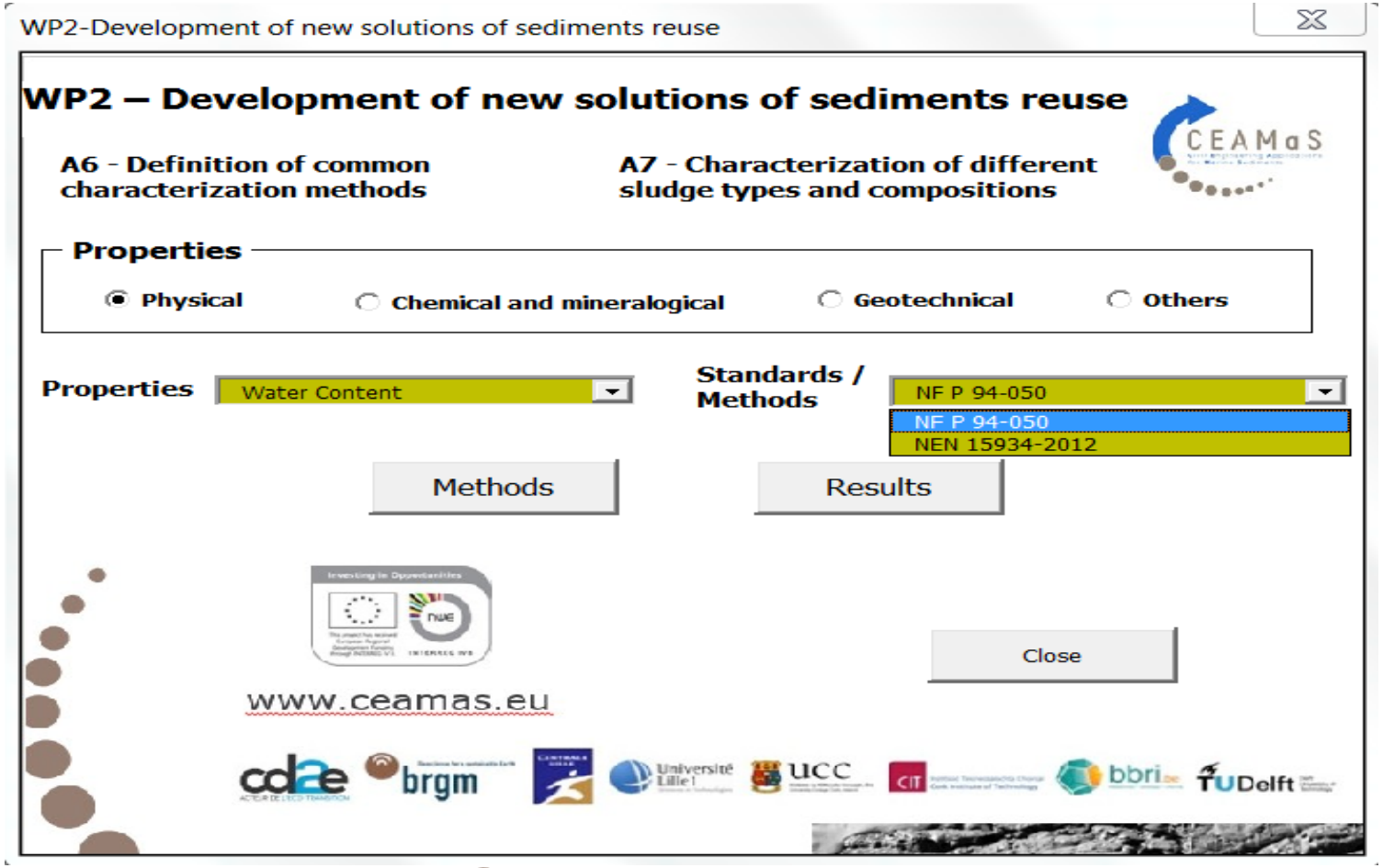
GEOTECHNICAL TESTS RESULTS

Atterberg Limits (NF P94-051)

	Liquid limit (LL)	Plastic limit (PL)	Plasticity index (PI)
Dunkirk	65,15	33,27	31,88
Amoras	85,97	32,25	53,72
Cork	-	-	-
Lowlands	530,1	232,89	297,21

TECHNICAL ISSUES FOR REUSE

SEDIMENT CHARACTERISATION TECHNICS FOR REUSE



APPLICATIONS

Road construction

Road embankment, fines	Road embankment, sand	Road embankment, self clear	Road sub base	Parking lot road surface
				

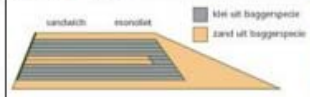
Soils

Soil elevation (meadow depo	Lift up of Lowlands	Wet storage (deposit)	Filter cake press	
				

Soils

Nature development, on land	Nature development, wetland	Sand seperation	Hydrocyclone for sand separa	Natural Ripening
				

Soils

Enhanced ripening with geot	Landfarming	Energy crops	Sound walls	Capping of deposits
				

APPLICATIONS

Dikes and safety against flooding

Trench shoring

River Embankment

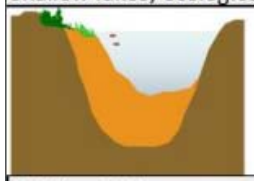
Dike, river site scouring prote

Dike, land site terrace

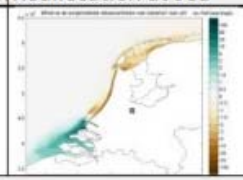
Lake, erosion protection

Dikes and safety against flooding

Shallow lakes, ecological enh



Reallocation at sea



Sediment store (baggerbuffer

Sediment settler (trapping)

Terp (local ground elevation)

Building industry

Brick production

Artificial gravel production

Artificial basalt

Concrete for roads/coastal de

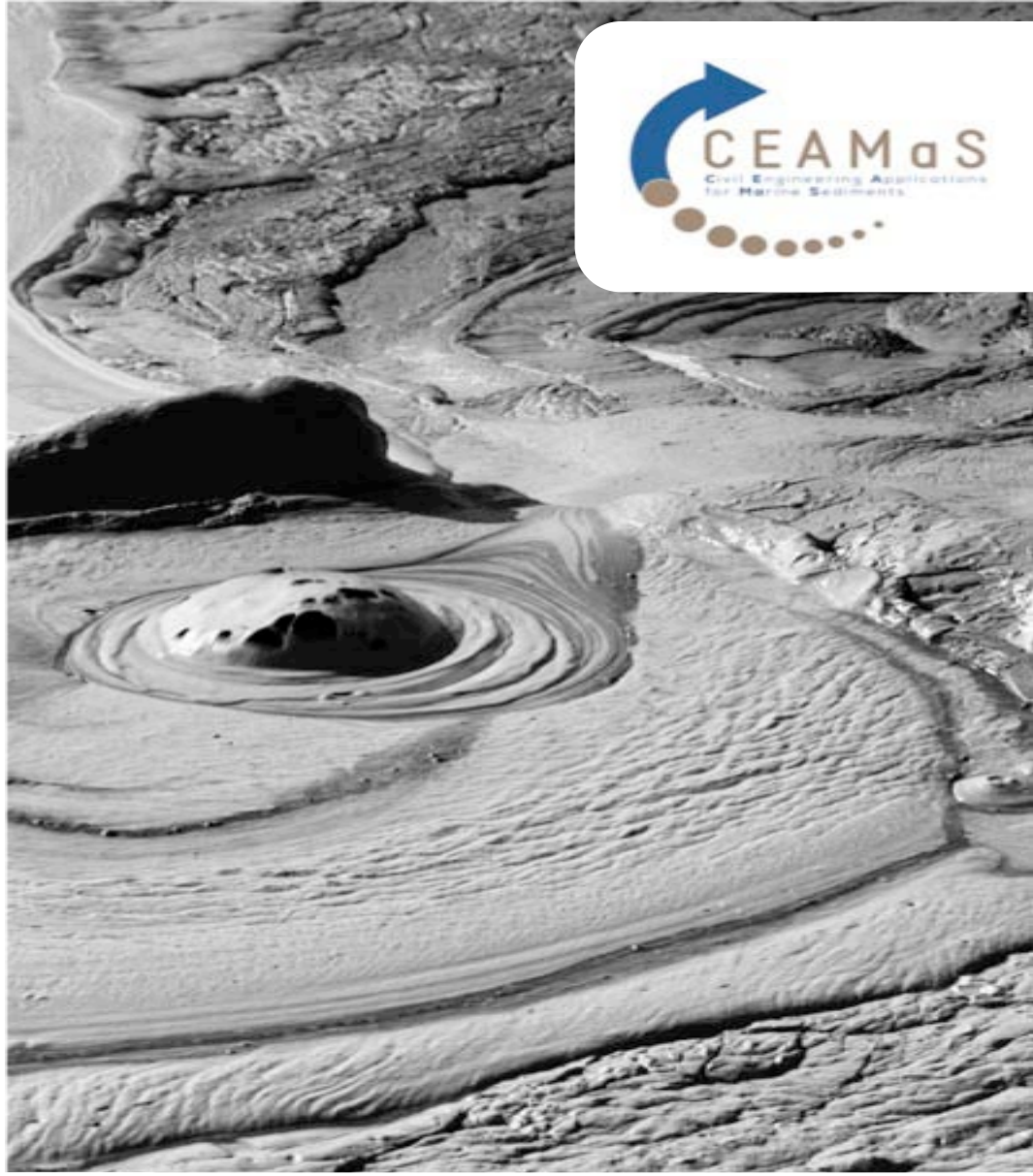
Cement mortar production

Building industry

Cement granulate productior

Stabilisation/Solidification

Thank you!



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A WHAT-IF TOOL

- A « what-if » decision support environment :
  - to simulate the various consequences of available management options
  - to take into account possible options in Belgium, France, Ireland and the Netherlands
  - Indirect benefits for options that would not be retained in a local tendering process (widened system boundaries)

- => Exchange and sharing for return on experience between each country

TARGET AUDIENCE

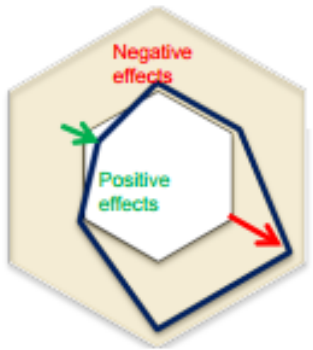
- Goals of the CEAMaS decision tool:
  - to allow various users to explore sediment management options in a port situation, and discuss them within the same framework
  - to act as a hub for the other more detailed tools or studies of the CEAMaS project, and beyond them, in the European Centre for Resources

- Targeted users:
  - students and communities, not necessarily with a high technical background
  - port decision makers and territorial authorities
- The tool includes specific points of view for civil engineering companies that can reuse sediment.

100% reference scale = « worst » scenario

Decision risk level
note

Cost assessment
k€



Improvement due to sediment management

Damage due to sediment management

Compared to the « nothing done » option

	Convention OSPAR	Convention de Londres	Convention de Barcelone	Convention de Helsinki
Date d'application	1992	1972 - 1996	1978 - 1995	2000
Echelle géographique	Atlantique nord-est	Pays contractants	Mer Méditerranée	Mer Baltique
Objectifs	Protection du milieu marin	Protection du milieu marin	Protection du milieu marin	Protection de l'environnement marin
Gestion des sédiments	Possibilité d'immerger les sédiments de dragage.			
	Caractérisation du sédiment en vue de l'immersion.			
	Pas de solution lorsque les sédiments ne peuvent pas être immergés.			
Guides et ouvrages de référence	- Guide pour la caractéristaion des sédiments de dragage.	- Instructions pour l'évaluation des sédiments de dragage - Guide pour la mise en place de seuils pour les sédiments de dragage.	- Protocole « immersions »	-