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SUSTAINABLE MANAGEMENT OF DREDGED MARINE SEDIMENTS IN APULIAN TOURIST PORTS

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SUSTAINABLE MANAGEMENT OF DREDGED MARINE SEDIMENTS IN APULIAN TOURIST PORTS

Politecnico di Bari

asset

DREDGING OF MARINE SEDIMENTS

Frequent silting of boats causes various **navigation challenges** due to the accumulation of submarine sediments

PERIODIC NEED TO DREDGE

+

LARGE QUANTITIES OF CONTAMINATED SEDIMENT

=

RESEARCH BACKGROUND

IERI
D.Lgs. 22/1997

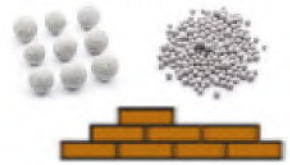
DRAGAGGIO → TRASPORTO → SMALTIMENTO



OGGI
D.M. 172/2016

DRAGAGGIO → TRATTAMENTO → RIUTILIZZO





WASTE ≠ **SEDIMENT** → **RESOURCE**

RESEARCH BACKGROUND

Dredging → Transport → SW/SS Treatments → Reuse

ART. 184-QUATER OF LEGISLATIVE DECREE 152/2006

Use of dredging materials:

1. **Dredged materials** subjected to recovery operations in containment basins or other authorized facilities, **cease to be classified as waste if, after recovery operations sorting, Which may also consist of sorting and selection operations,** they meet certain requirements and **conditions:**
   a) do not exceed threshold contamination concentrations... (Table 1, Annex 5, Title V, Part IV of Legislative Decree 152/2006), based on the site's urban destination, or, in the case of direct use in a production cycle, meet the technical requirements referred to in paragraph b), second sentence;
   b) the destination site is certain, and the materials are used directly, including for reuse or environmental reshaping purposes, without risks to the affected environmental matrices, and particularly without causing contamination of groundwater and surface water. In cases of direct use within a production cycle, they must instead comply with the technical requirements for the specific purposes identified, the regulations, and the existing standards applicable to products and raw materials. Specifically, they must not result in environmental emissions that exceed or differ qualitatively from those generated by the use of products and raw materials for which authorization for plant operation has been granted.
2. To eliminate the risk of groundwater contamination, dredged materials intended for use at a site must undergo **leaching tests** (in accordance with the methods and limits specified in Annex 3 of the Ministerial Decree of February 5, 1998).

DREDGING IN APULIA

As part of the project "**Interventions for the competitiveness of the port and interport system**" (POR Puglia 2014–2020), Puglia Region allocated approximately **€48 million euro** for **dredging** marine seabeds and **managing extracted sediments.** 12 project proposals have been deemed eligible so far, including:

BENEFICIARY

Municipality of Barletta

City of Castro

Municipality of Salve

Municipality of Otranto

Municipality of Ugento

Municipality of Rodi Garganico

Municipality of Molfetta

Municipality of Mola di Bari

Municipality of Ostuni

Municipality of Morciano di Leuca

Municipality of Fasano

Municipality of Tricase

Port of Barletta

Port of Taranto

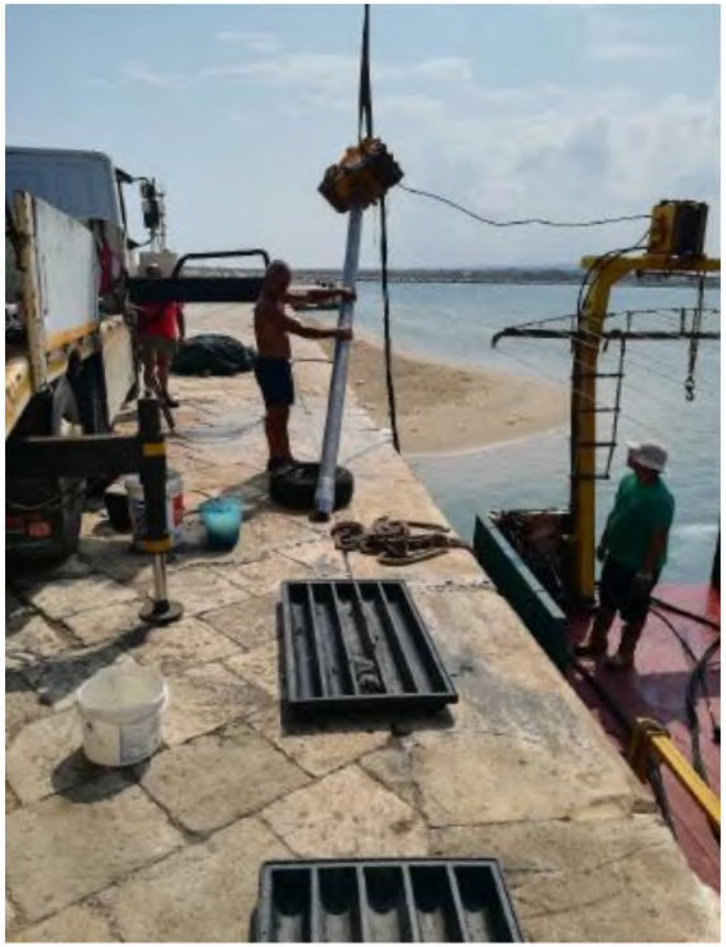
Port of Molfetta

Port of Bari

CASE STUDY 1: THE PORT OF MOLA DI BARI

PORT OF MOLA DI BARI

Subject to silting phenomena that cause **navigability issues** in the basin. Therefore, for the purposes of dredging, **activities for characterizing** the seabeds were carried out (in accordance with Ministerial Decree 173/2016).



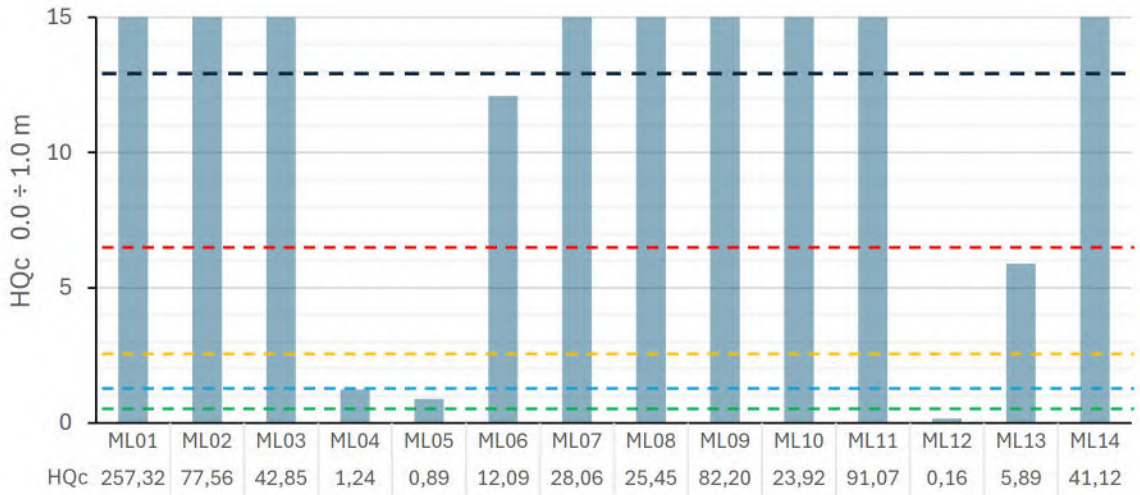
PORT OF MOLA DI BARI

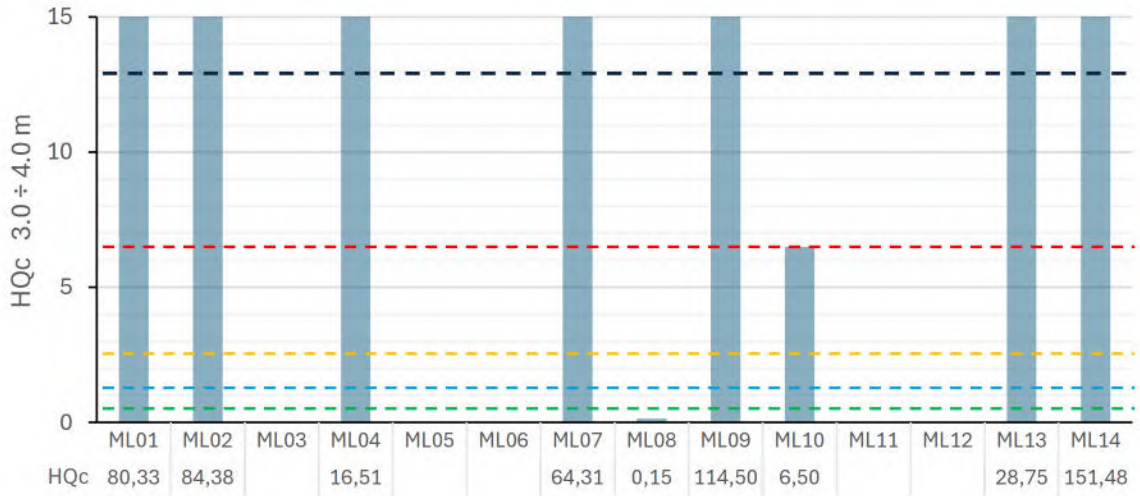
Campione	L1	L2	HQ (L1)	Max % contr a HQ (L1)	N. param. non conformi (L1)	HQ (L2)	Max % contr a HQ (L2)	N. param. non conformi (L2)
ML09/SC050-100	MOLTO ALTO	MOLTO ALTO	121.95	89.7 - TBT	9	17.83	88 - Somma_organostannici	2
ML09/SC100-200	MOLTO ALTO	ALTO	100.42	16.3 - TBT	19	9.45	51.7 - Somma_organostannici	3
ML09/SC200-280	MOLTO ALTO	MOLTO ALTO	114.5	45.5 - TBT	18	22.12	82.8 - Somma_organostannici	3
ML10/SC000-050	MOLTO ALTO	ASSENTE	28.31	14.2 - Benzo_a_pirene	12	0.19		0
ML10/SC050-100	MOLTO ALTO	ASSENTE	19.53	17.7 - Benzo_a_pirene	8	0.12		0
ML10/SC100-200	MEDIO	ASSENTE	5.22	39.6 - Benzo_a_pirene	3	0.08		0
ML10/SC200-300	MEDIO	ASSENTE	6.5	28 - Benzo_k_fluorantene	4	0.07		0
ML11/SC000-050	MOLTO ALTO	ALTO	89.31	55.5 - TBT	15	12.5	76.3 - Somma_organostannici	3
ML11/SC050-100	MOLTO ALTO	MOLTO ALTO	92.82	59 - TBT	16	13.66	78 - Somma_organostannici	3
ML11/SC100-180	MOLTO ALTO	ALTO	87.17	19.7 - TBT	16	9.63	56.1 - Somma_organostannici	3

The chemical and eco-toxicological characterization of the sediments was integrated and analyzed using the **Sediqualsoft** software (ISPRA) in accordance with the technical annex of Ministerial Decree 173/2016

Analytical determinations confirmed the **contamination** of sediments by various chemical compounds, both **inorganic** (e.g., Cu, Ni, Pb) and **organic** (e.g., benzo[a]pyrene, benzo[k]fluoranthene, anthracene, organotin compounds)

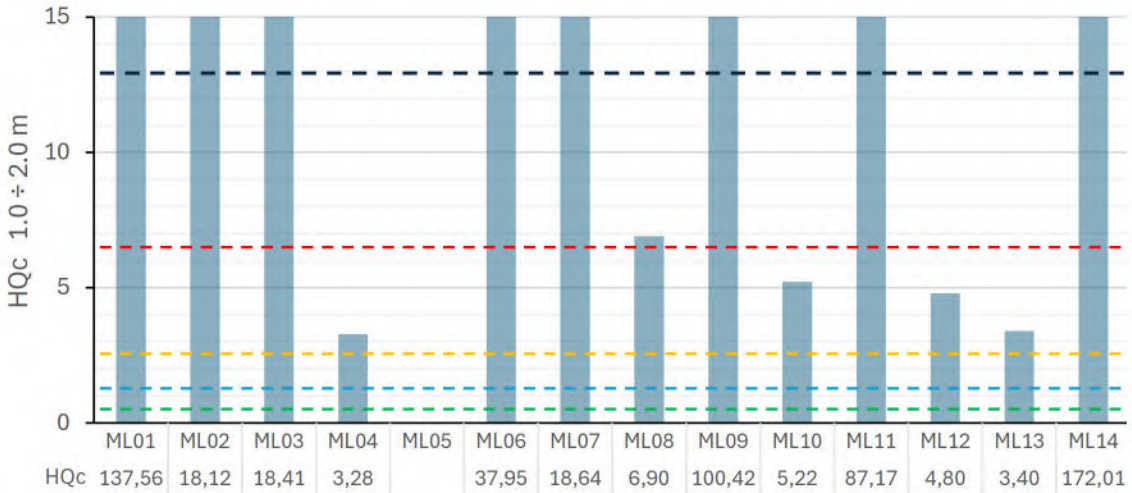
PORT OF MOLA DI BARI



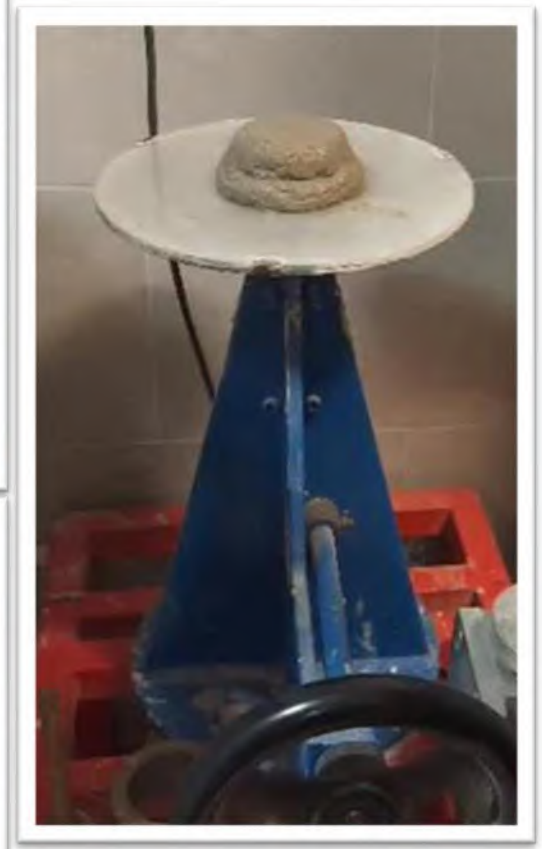


The application of **Sediqualsoft** software returned a **variable** sediment quality classification according to function:

- of the **sampling area**;
- of the **depth of sample collection**.



EXPERIMENTAL ACTIVITIES



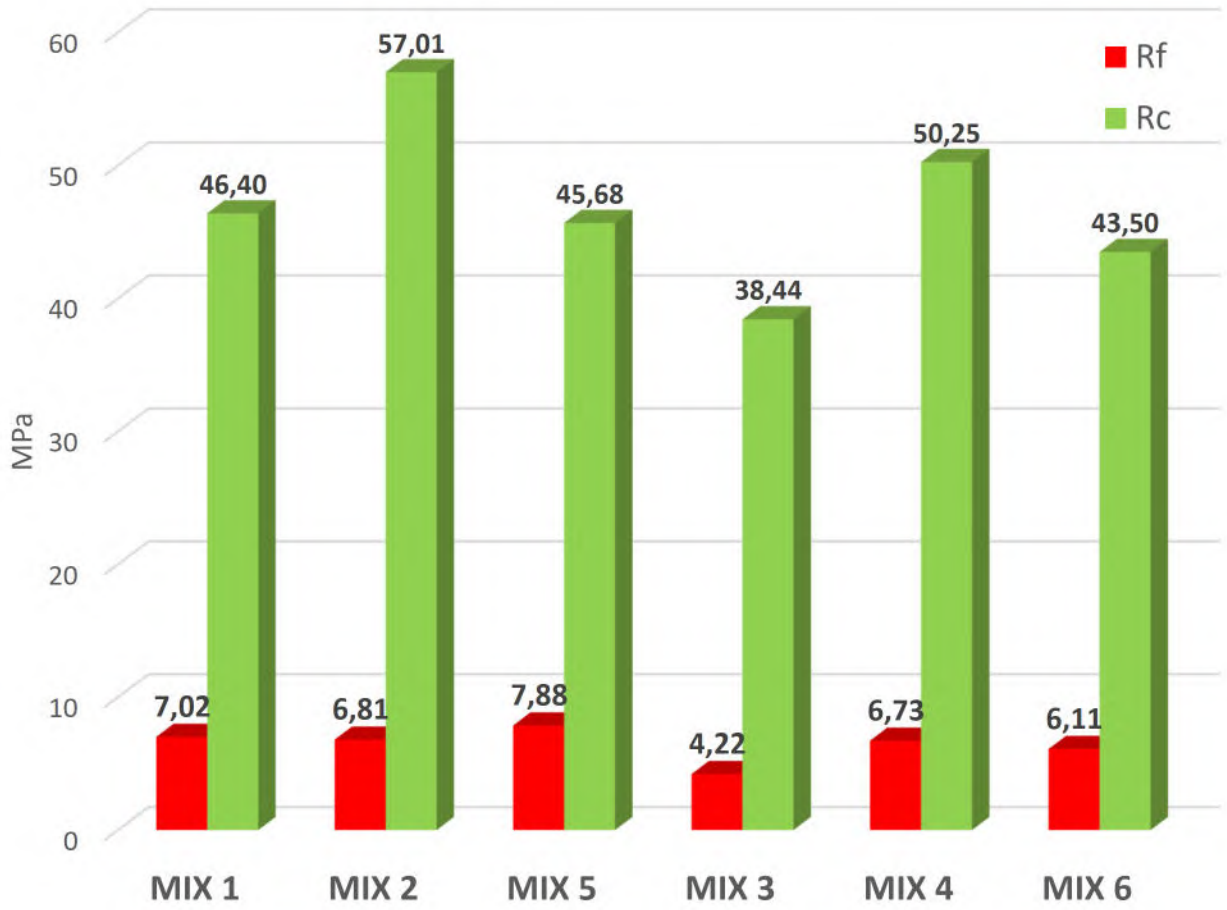
STABILIZATION/SOLIDIFICATION

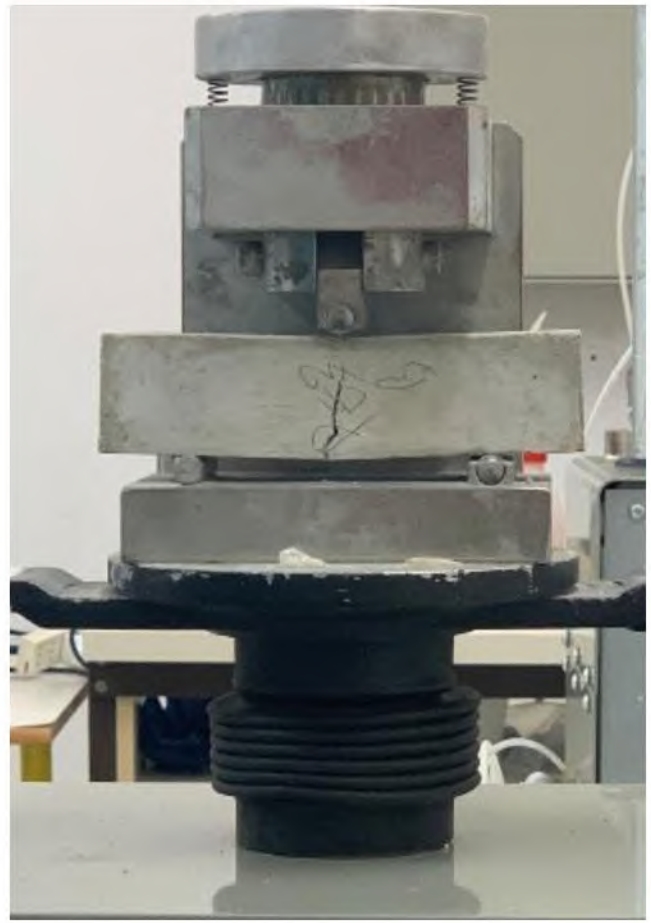
Portland cement CEM I 42.51

H_2O

SEDIMENT AS IT IS	
MIX 1	40% CEM + 20% H_2O + 40% S_1
MIX 2	40% CEM + 20% H_2O + 40% S_2
MIX 5	630g CEM + 20% H_2O + 20% S_1 + 20% S_2
WASHED SEDIMENT	
MIX 3	40% CEM + 20% H_2O + 40% S_{1_L}
MIX 4	40% CEM + 20% H_2O + 40% S_{2_L}
MIX 6	630g CEM + 20% H_2O + 20% S_{1_L} + 20% S_{2_L}

STABILIZATION/SOLIDIFICATION

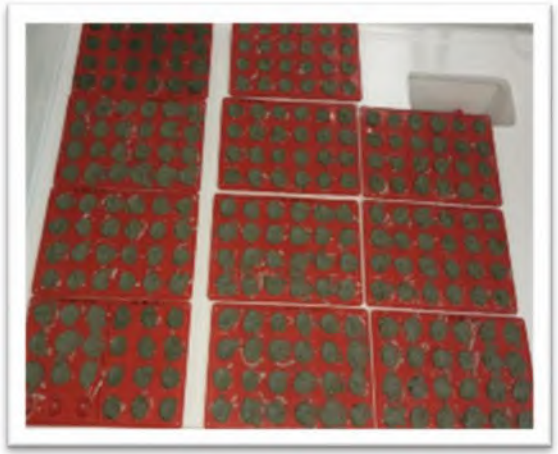




CASE STUDY 2: THE MAR PICCOLO OF TARANTO

MAR PICCOLO OF TARANTO

EXPERIMENTAL ACTIVITIES



STABILIZATION/SOLIDIFICATION

CONTAMINATED SEDIMENTS

Parameters	UdM	MIX_1	MIX_2
pH	u. pH	8.93	8.82
Eh	mV	-110.0	-100.7
Conductivity	mS/cm	3.05	4.78
Moisture	%	49.79	44.63
Ash at 550°C	%	79.47	89.14
Volatile solids	%	21.53	10.86
Particle size			
Sand fraction, SF	%	18.86	19.44
Silt fraction, MF	%	45.32	43.18
Clay fraction, CF	%	35.82	37.38

Contaminants	UdM	MIX_1	MIX_2
Hg	mg/kg ss	3.68	1.99
Pb	mg/kg ss	82.11	91.45
Cu	mg/kg ss	64.59	59.00
Zn	mg/kg ss	135.32	172.73
PAHs	μg/kg ss	101	5732
PCBs	μg/kg ss	23	1523

In yellow are the values above the site-specific limits for the Taranto SIN (ICRAM, 2004)

STABILIZATION/SOLIDIFICATION

Cement Portland CEM I 42.51

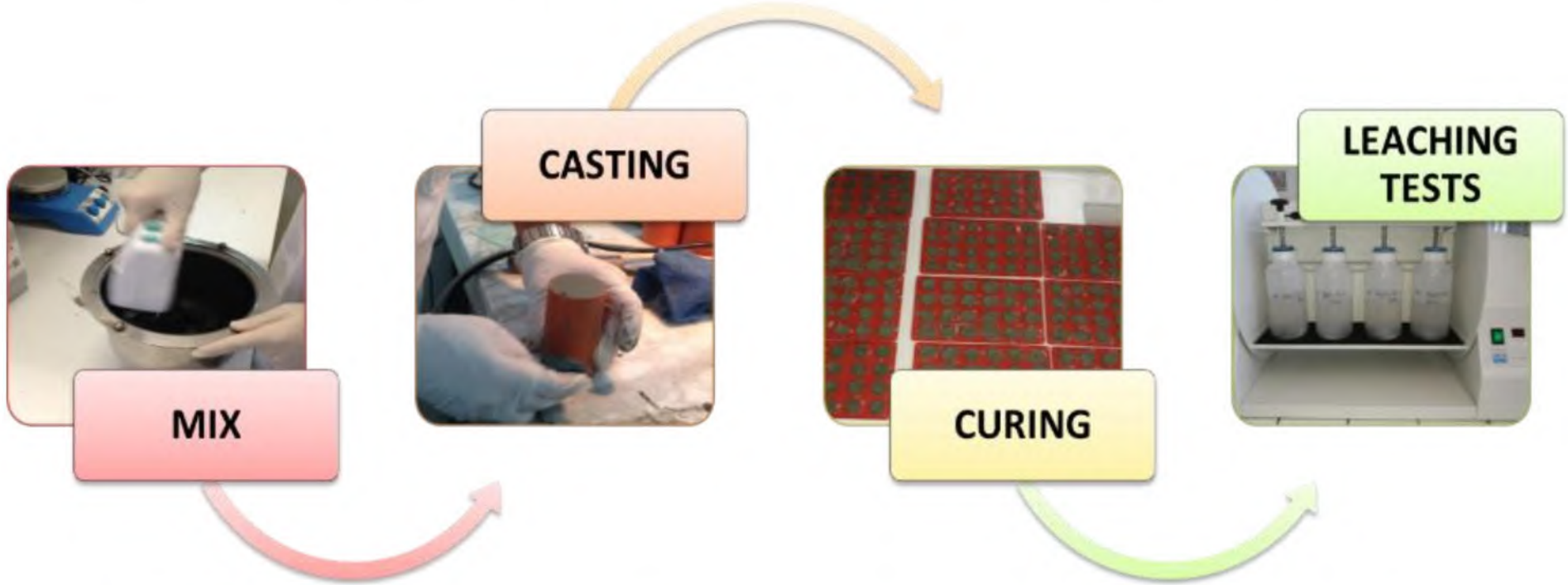
Calcium hydroxide (LIME)

CEM 1	10 % CEM
CEM 2	10 % CEM + 5% **OC**
CEM 3	10 % CEM + 5% **AC**
CEM 4	10 % CEM + 2.5% **AC** + 2.5% **OC**
LIME 1	10 % LIME
LIME 2	10 % LIME + 5% **OC**
LIME 3	10 % LIME + 5% **AC**
LIME 4	10 % LIME + 2.5% **AC** + 2.5% **OC**

ORGANOCLAY (OC)

Active Charcoal (AC)

STABILIZATION/SOLIDIFICATION



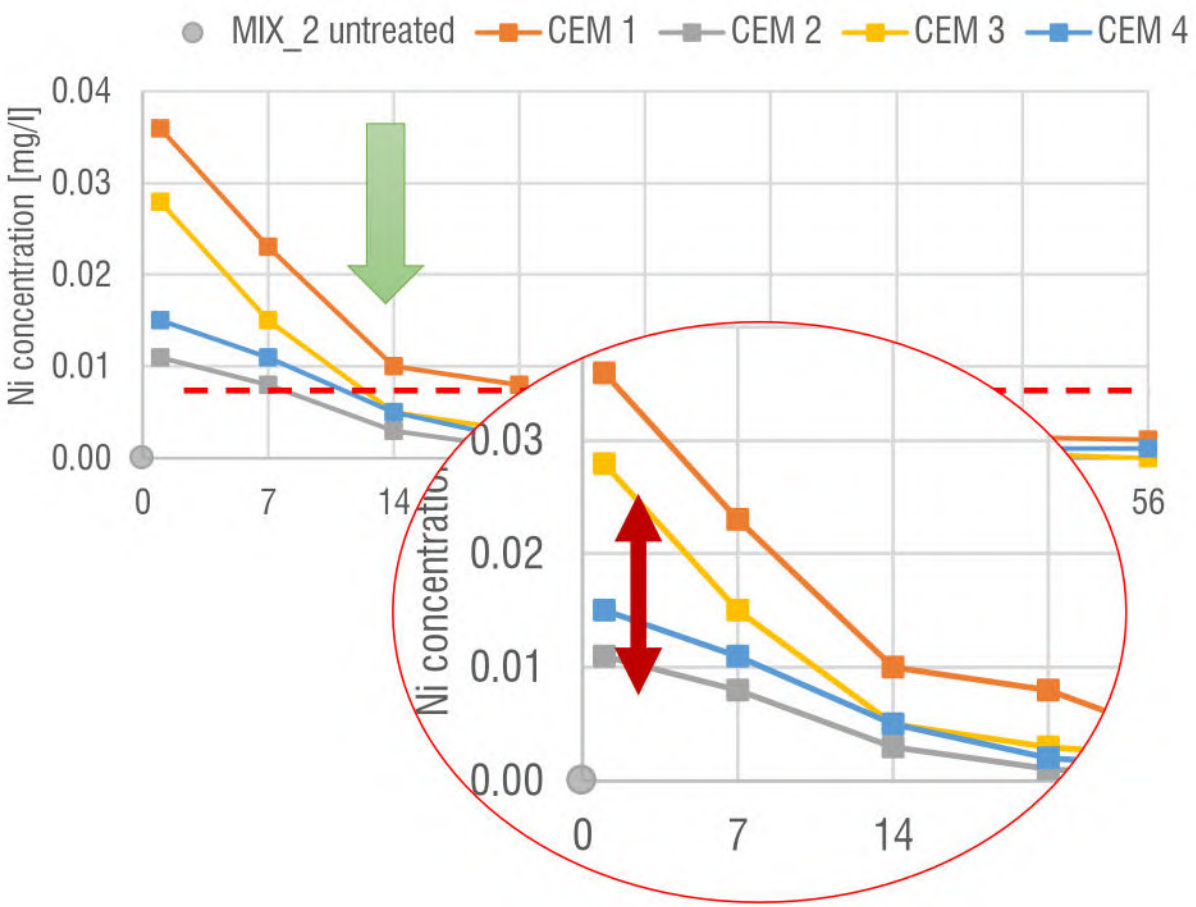
RECOVERY UNDER SIMPLIFIED PROCEDURE

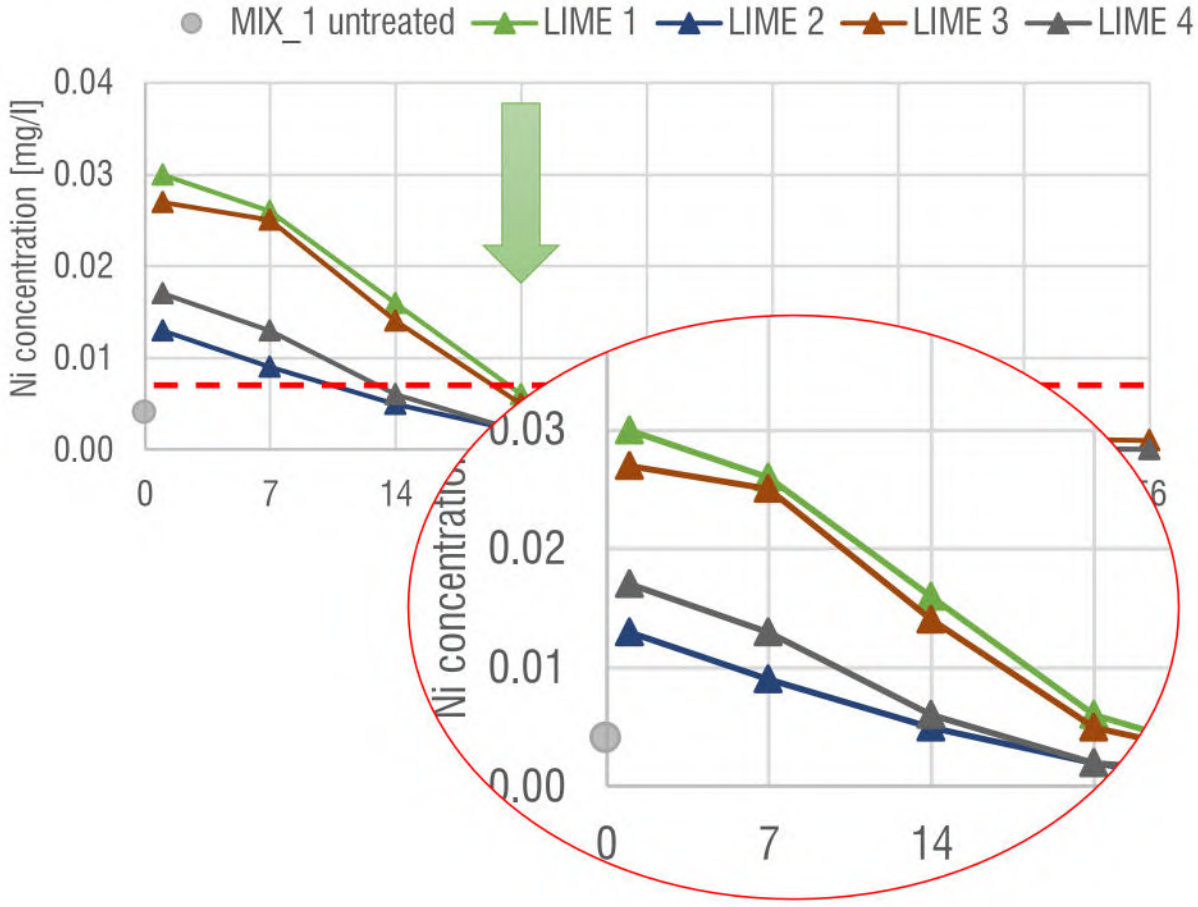
Test di cessione UNI 10802 / ENV 12457-2 (Valori limite)

Parametri	Unita' di misura	Concentrazioni limite
Nitrati	Mg/l NO3	50
Fluoruri	Mg/l F	1,5
Solfati	Mg/l SO4	250
Cloruri	Mg/l Cl	100
Cianuri	microngrammi/l Cn	50
Bario	Mg/l Ba	1
Rame	Mg/l Cu	0.05
Zinco	Mg/l Zn	3
Berillio	microngrammi/l Be	10
Cobalto	microngrammi/l Co	250
Nichel	microngrammi/l Ni	10
Vanadio	microngrammi/l V	250
Arsenico	microngrammi/l As	50
Cadmio	microngrammi/l Cd	5
Cromo totale	microngrammi/l Cr	50
Piombo	microngrammi/l Pb	50
Selenio	microngrammi/l Se	10
Mercurio	microngrammi/l Hg	1
Amianto	Mg/l	30
COD	Mg/l	30
PH		5,5 < > 12,0

STABILIZATION/SOLIDIFICATION

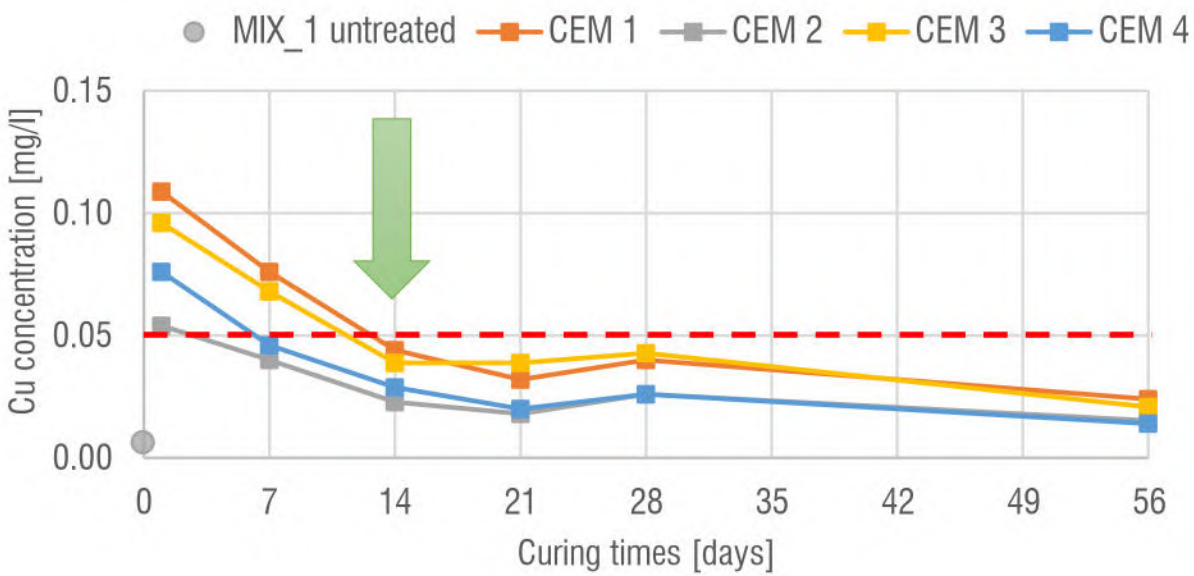
Nickel

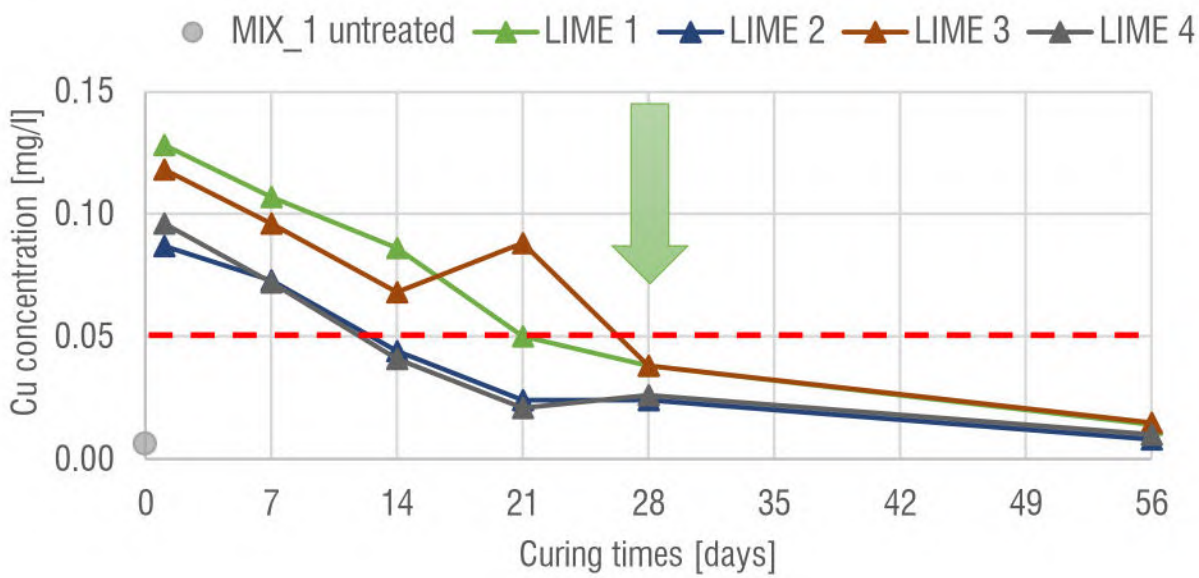




STABILIZATION/SOLIDIFICATION

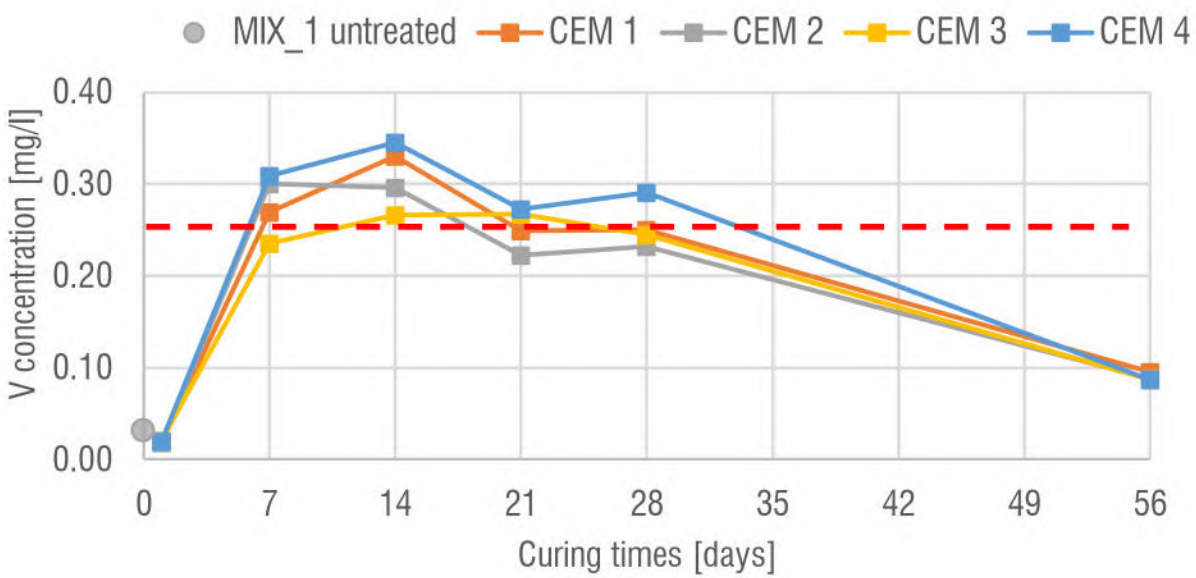
Copper

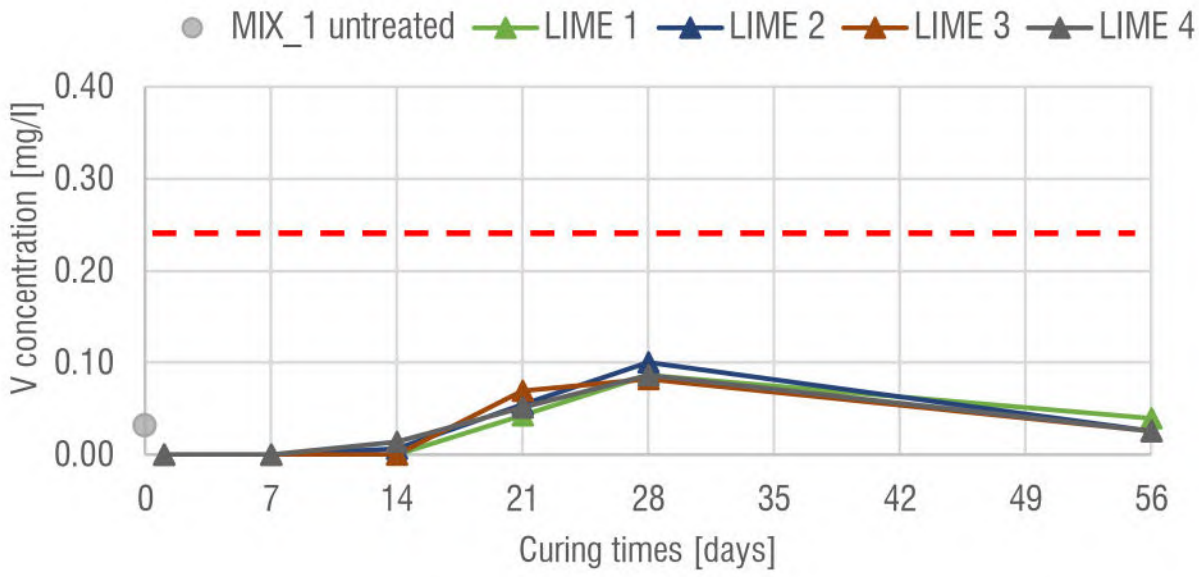




STABILIZATION/SOLIDIFICATION

Vanadium





STABILIZATION/SOLIDIFICATION

MIX 1 - Assessment of environmental performance (28 days)

Mix	Unit	Metals							
		As	Co	Cr	Ni	Pb	V	Cu	Zn
CEM 1	mg/l	0.016	< LOD	0.006	< LOD	< LOD	0.250	0.040	< LOD
CEM 2	mg/l	0.015	< LOD	0.006	0.006	< LOD	0.232	0.026	< LOD
CEM 3	mg/l	0.016	< LOD	0.007	< LOD	< LOD	0.245	0.043	< LOD
CEM 4	mg/l	0.017	< LOD	0.008	< LOD	0.001	0.291	0.026	< LOD
LIME 1	mg/l	0.007	< LOD	0.007	0.002	< LOD	0.086	0.038	< LOD
LIME 2	mg/l	0.006	< LOD	0.006	< LOD	< LOD	0.100	0.024	< LOD
LIME 3	mg/l	< LOD	< LOD	0.006	0.002	< LOD	0.082	0.038	< LOD
LIME 4	mg/l	< LOD	< LOD	0.006	0.001	< LOD	0.086	0.026	< LOD

STABILIZATION/SOLIDIFICATION

MIX 2 - Assessment of environmental performance (28 days)

Mix	Unit	Metals							
		As	Co	Cr	Ni	Pb	V	Cu	Zn
CEM 1	mg/l	0.009	< LOD	0.009	0.003	< LOD	0.255	0.087	< LOD
CEM 2	mg/l	0.007	< LOD	0.011	< LOD	< LOD	0.314	0.034	< LOD
CEM 3	mg/l	0.009	< LOD	0.010	< LOD	< LOD	0.297	0.045	< LOD
CEM 4	mg/l	0.009	< LOD	0.008	< LOD	< LOD	0.250	0.035	< LOD
LIME 1	mg/l	< LOD	< LOD	0.010	0.005	< LOD	0.086	0.089	< LOD
LIME 2	mg/l	0.006	< LOD	0.007	< LOD	< LOD	0.006	0.032	< LOD
LIME 3	mg/l	0.005	< LOD	0.010	< LOD	< LOD	0.006	0.064	< LOD
LIME 4	mg/l	0.006	< LOD	0.007	< LOD	< LOD	0.006	0.048	< LOD

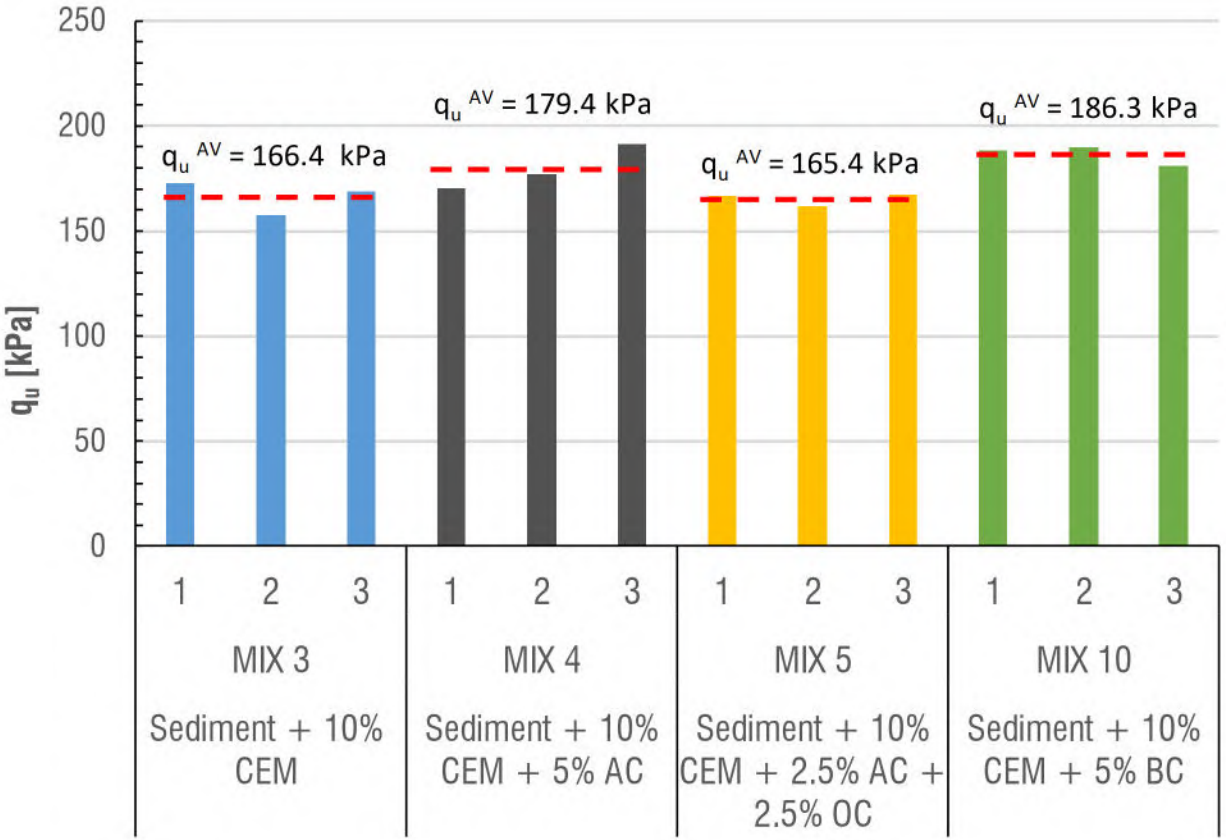
STABILIZATION/SOLIDIFICATION

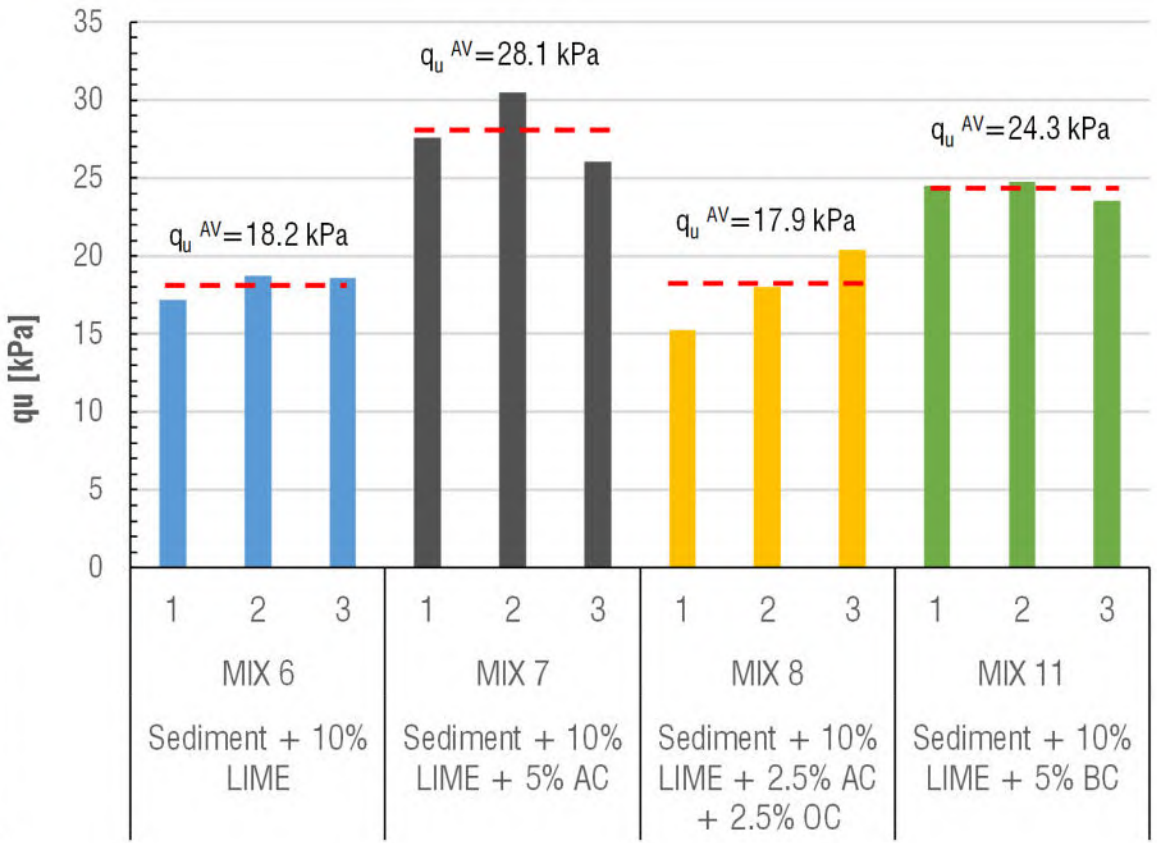
MIX 2 - Assessment of environmental performance (56 days)

Mix	Unit	Metals							
		As	Co	Cr	Ni	Pb	V	Cu	Zn
CEM 1	mg/l	0.009	< LOD	0.009	0.003	< LOD	0.005	< LOD	< LOD
CEM 2	mg/l	0.007	< LOD	0.011	< LOD	< LOD	0.004	< LOD	< LOD
CEM 3	mg/l	0.009	< LOD	0.010	< LOD	< LOD	0.007	< LOD	< LOD
CEM 4	mg/l	0.009	< LOD	0.008	< LOD	< LOD	0.006	< LOD	< LOD
LIME 1	mg/l	< LOD	< LOD	0.010	0.005	< LOD	0.006	< LOD	< LOD
LIME 2	mg/l	0.006	< LOD	0.007	< LOD	< LOD	0.006	< LOD	< LOD
LIME 3	mg/l	0.005	< LOD	0.010	< LOD	< LOD	0.006	< LOD	< LOD
LIME 4	mg/l	0.006	< LOD	0.007	< LOD	< LOD	0.006	< LOD	< LOD

STABILIZATION/SOLIDIFICATION

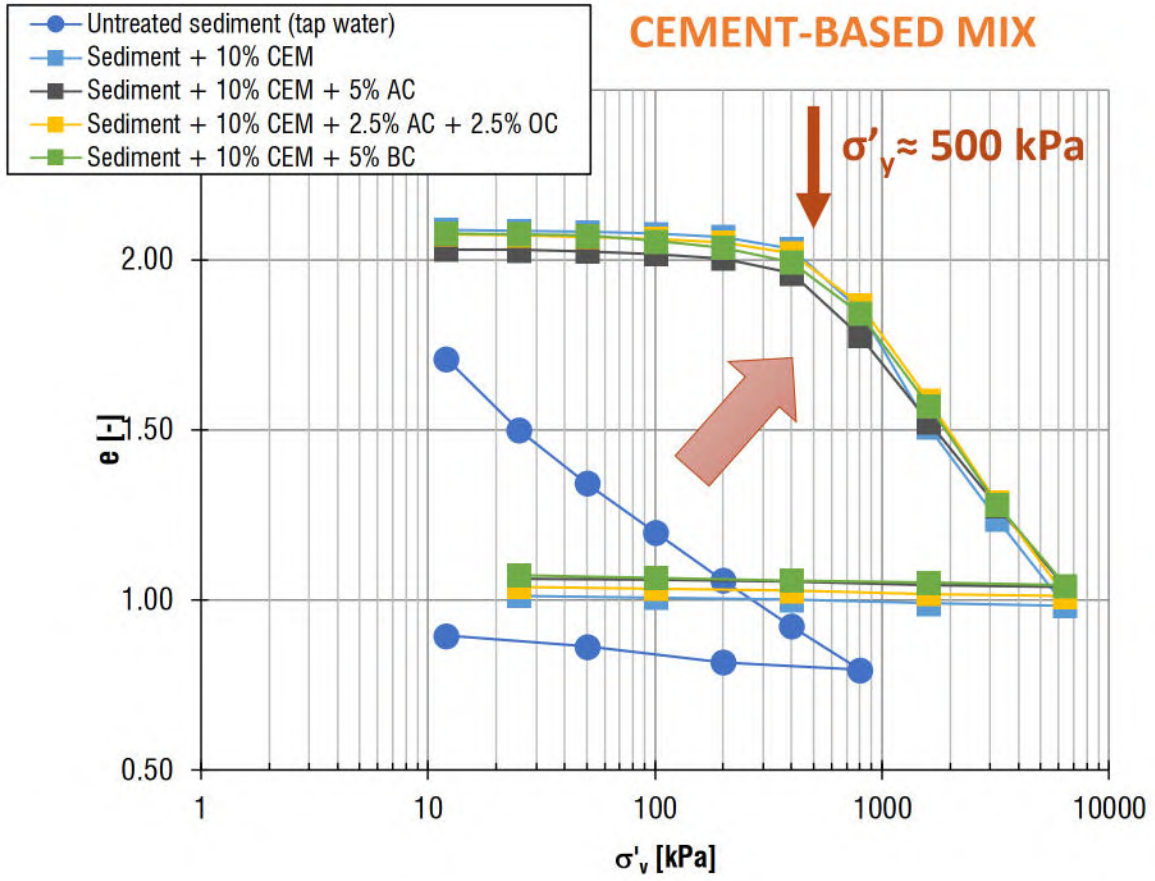
FREE LATERAL EXPANSIONS

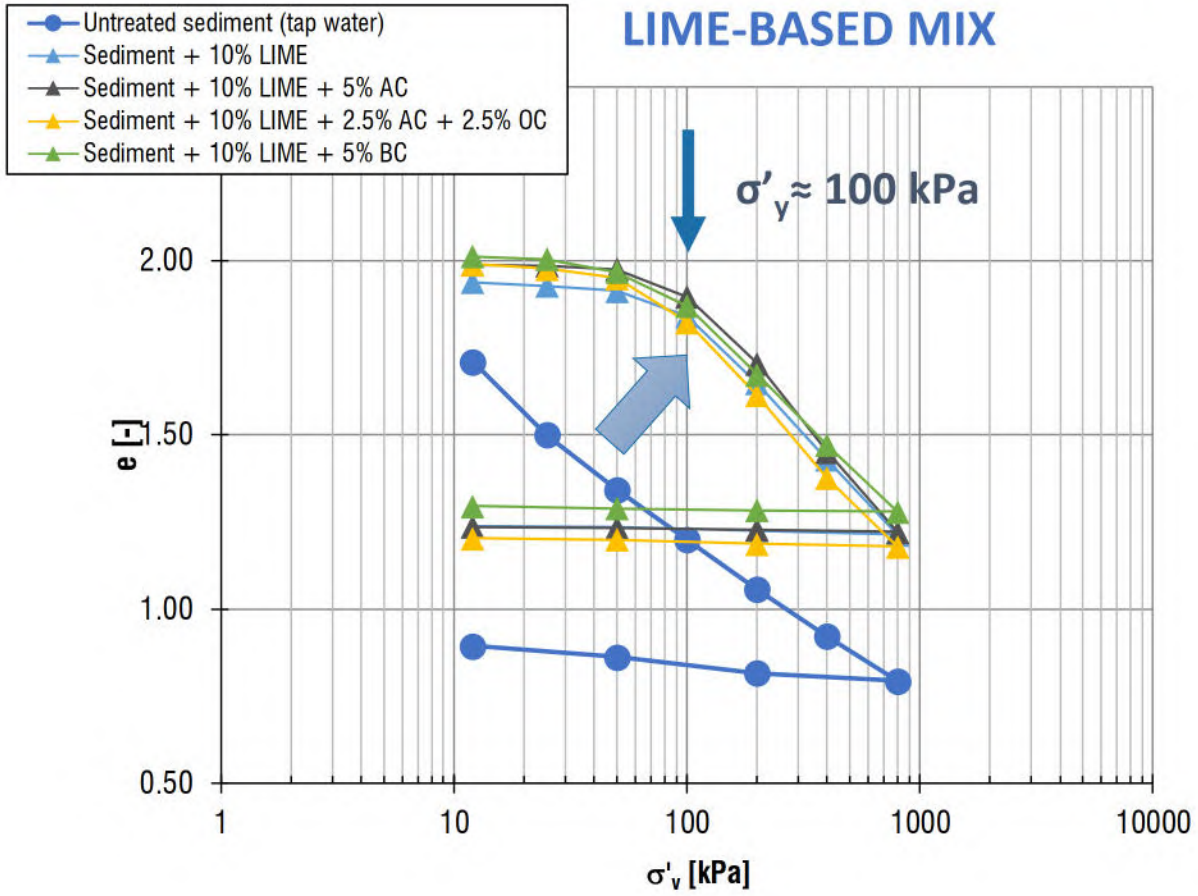




STABILIZATION/SOLIDIFICATION

Edometric tests (28 days)





CONCLUSIONS

1. The sustainable management of dredged sediments requires recovery strategies capable of delivering economic, environmental, and social benefits.

2. Inertization (i.e., Stabilization/Solidification) represents a valid strategy for the sustainable management of dredged sediments, enabling the cessation of their classification as waste.

3. It is essential to note that selecting the best remediation/recovery alternative requires considering the treatment's efficiency in terms of the reuse of the treated materials.

GREENLIFE4SEAS - Approach and Strategy

Thank you for your attention