



Soil Stabilisation Decommissioning

Soil Regenerative Process









All regenerative systems start by measuring and understanding the existing soil conditions.

The measurements taken will cover aspects of the **Physical**, **Chemical** and **Biological** functionality of the soil and interpreting these aspects to find out the limiting factor to soil functionality. These principles are used in the following Decommission strategy.

The more we know about the subsoil before we start the better, therefore we should test the soil and then try and balance it back post treatments.

Understanding the effect of the stabilisation process on soils through the Pulverisation, Binder addition and Compaction is essential for compiling the Decommissioning Strategy **DECOMSTRAT**.

The **Decomstrat** will require a full suite of tests to be carried out prior and post soil stabilisation. Allowing for correct reinstatement.

Soil knowledge leads to the correct remedial activity, resulting in a fully functional soil.





Citation ISO Certificat

ortificate No:33416201



Citotion ISO Certification Quality ISO 9001: 2015 Certificate No.334152019



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Soil Tests: using the TerraMap Gold test

Tests are required to be carried out at each stage of the Decommissioning Process.

Testing of the Natural Untreated Soil Testing of the Binder Treated Soil Testing of the Regenerated Soil

TerraMap Gold Analysis

An examination of the chemical, biological and physical aspects of the soil. Extensive understanding of how and why the soil performs. Presented on digital maps and paper reports.

The 42 parameters TerraMap Gold test includes amongst others:

- Active (water) pH
- Buffer pH
- Soil texture
- Organic matter
- Organic carbon







TerraMap Scanning

TerraMap is the best soil mapping service with the most detailed soil analysis, all results are uploaded onto the best digital precision farming platform. No comparable service is available elsewhere on the UK market.

Onsite TerraMap Scanning



TerraMap scanning vehicles have a sensor on the back which picks up four isotopes from the soil. This informs the driver where to take soil samples for wet chemical testing using the interactive screen in the vehicle cab.







TerraMap Scan Data at Folkingham

The Ca:**Mag** ratio is very different in topsoil and subsoil: topsoil more free draining than subsoil due to a chemical imbalance in Calcium and Magnesium in the subsoil.

278-281 3.28 - 3.54 3.11 - 3.18

Whole Field Analysis of Ca:Mag

23.17 - 28.9 18.75 - 23.17 14.74 - 18.75 13.27 - 14.45



Haul Road Strip Analysis of Ca: Mag



Carbon:**Clay** highlighting lower Organic Matter/high Clay leading to different water and structure dynamics which can be clearly seen on the scan below.











Soil pH

The Stabilisation has increased the pH because of the Ca in the cement.

Remedial Action required

Natural State pH range 7.2 – 7.4



Cement Treated State pH elevated 7.9 - 8.1







Gold Soil Reports - Gold Soil Analysis

Gold Soil Analysis - Natural State Untreated

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Certificate No:334162019





Gold Soil Analysis - Subsoil Stabilised with Cement Binder

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Gold Soil Analysis – Decommissioned Soil

No Crop Given	General plough depth	Sand % Silt Clay %	Clay Loam Serve contract 2 (khrmun)	Dry BD 1.077	FieldBulk dewity if known 1.47	Estimated NB 32 kg of NB from OM TACMA Tarnet 110 ^{found} 101 TACM	ement recommendations		1200 Desired Cation% v Found	1000	0.8			20		Mg K Na other H Md CP 122 (245)		Plant health comments			tential (ESP) Na : K 0.41 Na should be lower than surface in rain. ratio OK	Biological Treatment		Foliar treatment								l Modified Morgan	mal Inde	sphorus 0 0	assium 0 0	nesium 0 U	atter 0 Hard testimo method for Furone
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Organic Matter and pH

The cement stabilisation has oxidised the organic matter seen by a reduction from 8.3 to 7.2 and an increase in Active Carbon %, the big rise in **pH** will increase bacterial content and Co2 release.

The 3rd result here shows the soil 5 weeks post treatment showing that the pH is dropping back to the original **pH** 7.9, and the organic matter has also increased showing that we are moving in the right direction. (5 weeks post treatment is not long for remedial action to work)

				-					-		
	Field ID:	FOLKINGHAM	ORIGINAL		Field ID:	FOLKINGHAM	TREATED		Field ID:	FOLKINGHAN	I GRASS
	An Ideal soil structu	re (Bd)	1.4		A Restricted soil struct	ture (B d)	1.56		An Ideal soil structur	e (B d)	1.4
ا & CEC	Active pH A moderately basic so Crop response	7.90 oil. ? Free lime. •s poor.	pH is restricting nutrient availability.	& CEC	Active pH FALSE FALSE	9.70	pH is restricting nutrient availability.	۱ & CEC	Active pH FALSE FALSE	8.60	pH is restricting nutrient availability.
ph	Buffer pH	7.30		hd	Buffer pH	8.40		ph	Buffer pH	7.70	
Active	e Carbon mg & %	468	1.03%	Active	e Carbon mg & %	382	1.18%	Active	e Carbon mg & %	271	0.63%
_	Organic Matter	Min >3%	8.30	_	Organic Matter	Min >3%	7.20	I	Organic Matter	Min >3%	7.80
NO NO	<u> Organic Carbon(LOI)</u>	Ideal 3%	4.87	No.	Jrganic Carbon(LOI)	Ideal 3%	4.23	õ	Organic Carbon(LOI)	Ideal 3%	4.58

This soil test was taken 5 weeks after the remedial action and we can see a good direction in travel.

The pH is dropping the organic matter is rising, the C:N ratio is stabilizing. Sulphur is still high but this will drop as the pH drops.

Other nutrients are good which will encourage good plant growth and rooting throughout the profile.







Testing the soil biology: PLFA analysis

Phospholipid **F**atty **A**cid analysis. PLFAs are an essential structural component of all microbial cellular membranes. PLFA analysis is a technique widely used for estimation of the total biomass and to observe broad changes in the community composition of the living microbiota of soil and aqueous environments.

Soil biological testing gives a representation of living soil microbial biomass, allowing us to identify the presence or absence of various functional groups of interest through known PLFA biomarkers.





PLFA test measures microbial activity in the soil, ground stabilisation has a very negative effect on soil biology:

Untreated Soil								Stabilised Soil							
Results	Unit	Result	low	rather Iow	average	rather high	high	Results	Unit	Result	low	rather low	average	rather high	high
Biological Microbial biomass	mg PLFA/kg	25						Biological Microbial biomass	mg PLFA/kg	< 0,6					
Total bacteria Gram positive Actinomycetes Gram negative Total fungi Arbuscular Mycorrhiza Other fungi Protozoa	mg PLFA/kg mg PLFA/kg mg PLFA/kg mg PLFA/kg mg PLFA/kg mg PLFA/kg mg PLFA/kg mg PLFA/kg	22 10 2,9 13 2,6 1,4 1,2 0,16					_	Total bacteria Gram positive Actinomycetes Gram negative Total fungi Arbuscular Mycorrhiza Other fungi Protozoa	mg PLFA/kg mg PLFA/kg mg PLFA/kg mg PLFA/kg mg PLFA/kg mg PLFA/kg mg PLFA/kg	< 0,6 < 0,3 < 0,2 < 0,3 < 0,2 < 0,2 < 0,2 < 0,1 < 0,1 < 0,03					
Shannon Wiener Index Fungal/bacterial ratio Gram(+)/Gram(-) ratio		1,28 0,8 0,8						Shannon Wiener Index Fungal/bacterial ratio Gram(+)/Gram(-) ratio		< 1,60 <1,2 <1,0					
Physical Acidity (pH) C-organic Organic matter SOC/SOM ratio	% %	7,0 2,68 4,5 0,60					-	Physical Acidity (pH) C-organic Organic matter SOC/SOM ratio Clay (<2 pm)	% %	10,5 2,02 5,2 0,39 45					
Clay (<2 pm) Organic matter Figure: Quality of the organic matter	% Stable	49						Organic matter Figure: Quality of the organic matter Dynamic Average	Stable						
Organic carbon held in micro-organisms Microbial biomass		mg C/kg 529						Organic carbon held in micro-organisms Microbial biomass		mg C/kg < 18					

Here we can see the reduction in biological activity following soil treatment.

If no biological remedial work is undertaken, soil functionality will be compromised.







Microbial Activity

The cement stabilisation has caused a major decrease in microbial activity and change in C:N ratios due to the death of the microbes. The Cement Stabilisation has effectively killed all biology in the soil.

Natural State subsoil prior to Stabilisation

Co2 Burst	35	Total Carbon	(Dum)	3.58
		Total N (Dum)	0.13	SOC/Clay
C:N ratio	27.54	Guide	12	11.5

Cement Stabilised Subsoil

Co2 Burst	4	Total Carbon	(Dum)	2.6
		Total N (Dum)	0.12	SOC/Clay
C:N ratio	21.67	Guide	12	11.2

Environment

Agency

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Treatment Plan - DECOMSTRAT

Effects of Cement Stabilisation on Subsoil: Raises pH

Reduces Organic Matter Reduces Microbial Activity De-structures the Soil

Actions Required:

Reduce pH to buffer level Increase Organic Matter in the soil Introduce Microbiology Re-structure the soil

All actions in the DECONSTRAT are determined by the TerraMap GOLD Test Analysis

Constructionline



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Folkingham Stabilisation Decommission Field Trial

CLAIRE Principal Member

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Stabilisation of Haul Road Track with 3% CEMI



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Haul Road Compaction to >30% CBR



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Pulverisation using Stabilisation Mixer to re-structure the stabilised layer

Samples for Gold Testing

















pH Re-Balancing

Ammonium Sulphate and Elemental Sulphur are applied to stabilise the pH and fertility levels in the subsoil.

Nutrients can leach through the profile, this is why we are addressing this through growing a cover crop.

Good topsoil management is the key to successful decommissioning of stabilised works. All the nutrients and structure will allow successful crop growth to take place within the topsoil.











Cover Crop Seeding

Early seeding trials in dishes showed very promising results in the Cement Stabilised soil with early establishment of seed growth.











Regenerative Process

Seeding was carried out on the pulverised soil to introduce organic matter and in turn reintroduce microbial activity

Seed mix contained Linseed, Buckwheat, Phacelia, Radish, Mustard, Hairy Vetch and Clover.









Six week established growth in the pH balanced and pulverised subsoil.

Fully established root systems and increased organic matter in the pulverised subsoil.















C	Crop biomass:	measure th	em	
Customer	Field	Cover crop	Sample date	Dm %
0	j17	Cover 1	02/07/2024	12.1
0	Kg/m2	T/Ha		
Fresh weight	3.2	32.00		
Dry weight	0.3872	3.87		
Element	% Dm	Kalla	Protein Kg/Ha	
Nitrogen	4.27	165.3344	909.3392	
Carbon	40.4	1504		
C:N Ratio		9.46	Miles	
C02		5740.94	28704.6848	
Breakdown speed	Fast	Elemental Kg/Ha	Oxides Kg/Ha	% WW Pd
Phosphate	0.52	20.1	48.3	40%
Potassium	3.56	137.8	105.4	37%
Calcium	2.51	97.2	136.1	139%
Magnesium	0.13	5.0	8.1	17%
Sulphur	0.63	24.4	61.0	51%
Element	PPM Dm	Grams/Ha		% WW Pd
Boron	29.1	112.6752		94%
Manganese	45.4	175.7888		20%
Zinc	30.2	116.9344		26%
Iron	1846	7147.712		286%
Copper	8.4	32.5248		27%
Molybdenum	1.65	6.3888		32%



Cover crop can capture (stop diffuse pollution) of potential environmentally harmful nutrients such as nitrogen and phosphate.











In summary: The soil is measured to ascertain its physical, chemical and bilogical status, all reinestatement works are designed to return this soil back to its native state.

These treatments include:	
Chemical intervention:	pH and humic acids,
Physical:	Pulverisation,
Biological:	Plant roots and biological inoculants.
Organical:	Wild Flower Planting

All targeted via Terra map digital mapping system, Gold Standard Analysis and PLFA Analysis.

Haul Road Decommissioned and topsoil fully reinstated after six weeks.





