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Ground Stabilisation

Focus on Carbon Net Zero and Sustainability



Soil Stabilisation Decommissioning

Temporary Works - Whole Life Cycle



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

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

The measurements cover the physical, chemical and biological functionality of the soil, interpreting these aspects to identify the limiting factor to soil functionality. These principles inform the following Decommissioning Strategy.

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 requires a full suite of tests before and after soil stabilisation, allowing for correct reinstatement.

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Soil testing pre-construction work

- TerraMap scanned and Gold soil tested, soil scanner detects 4 isotopes which informs the sampler where to collect soil samples for wet chemical testing.
- Scan and test results uploaded onto digital, interactive mapping platform Omnia, generate reports digitally or physical printouts.
- This will show the state and functionality of the soil, so there is a target to aim for when soil is reinstated.

Construction of Haul Roads

- Roadways are put in by normal practice after soil has been baseline assessed.
- Test the roadway again, once stabilised by hydrated lime and cement.
- Compare it to the original soil, allowing regenerative reinstatement plans to be made before roadway removal is considered.

Regenerative reinstatement plan

- Will cover physical, chemical and biological aspects of the soil, how to balance these to maximise soil functionality post-reinstatement and bring them as close (or better in some cases) to the original.
- Parameters include pH, organic matter, bulk density, microbial populations and diversity. Actions include chemical amendments, growing plants to stabilise soil and additions of native microbial consortiums.
- A clear, ordered programme of work will be issued, including a timeline, before reinstatement. Will include nutrients, seed rates, plant species and biological inoculants to be applied. This will allow for successful development of plants and microbial communities over time (minimum of 6 weeks post application).

Soil inspections post-reinstatement

- Carry out physical inspection of the soil profile and visual soil assessment.
- This is to ensure the regenerative reinstatement plan is working and the soil's natural functionality has been either restored or further enhanced.

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.
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

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TerraMap Scanning

TerraMap delivers detailed soil mapping and analysis, with all results uploaded onto a digital precision-farming platform for clear interpretation and comparison.

Onsite TerraMap Scanning



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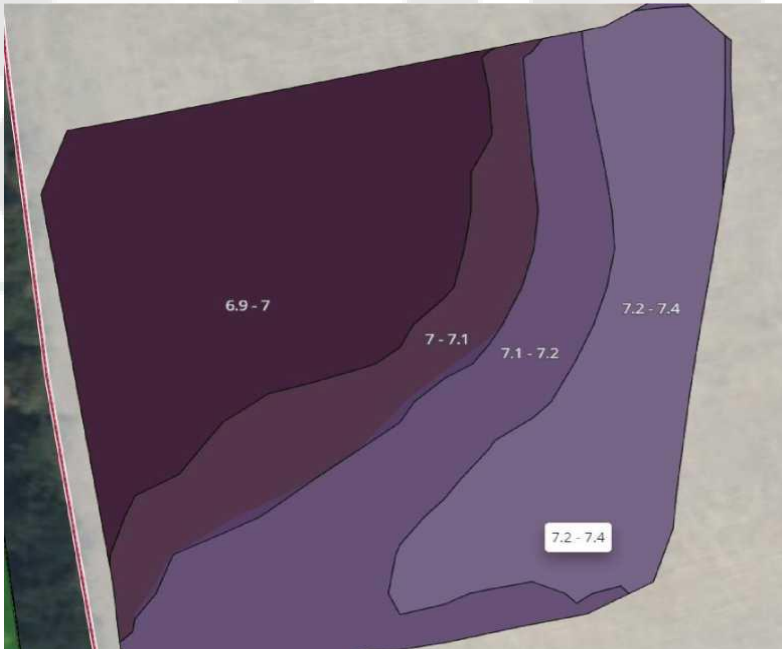
Soil pH

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

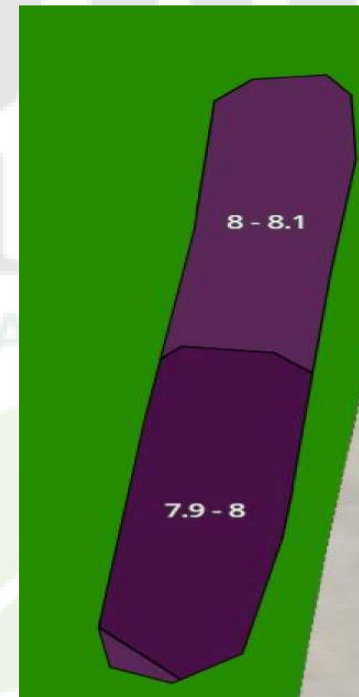
Remedial Action required



Natural State pH range 7.2 – 7.4



Cement Treated State pH elevated 7.9 – 8.1



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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: the pH is dropping back towards the original pH 7.9, and the organic matter has also increased, confirming that we are moving in the right direction.

Field ID: FOLKINGHAM ORIGINAL	
An Ideal soil structure (Bd)	
1.4	
ph & CEC	Active pH
	7.90
	pH is restricting nutrient availability.
A moderately basic soil. ? Free lime.	
Crop responses poor.	
OM	Buffer pH
	7.30
	Active Carbon mg & %
468 1.03%	
OM	Organic Matter
	Min >3% 8.30
OM	Organic Carbon(LOI)
	Ideal 3% 4.87

Field ID: FOLKINGHAM TREATED	
A Restricted soil structure (Bd)	
1.56	
ph & CEC	Active pH
	9.70
	pH is restricting nutrient availability.
FALSE	
FALSE	
OM	Buffer pH
	8.40
	Active Carbon mg & %
382 1.18%	
OM	Organic Matter
	Min >3% 7.20
OM	Organic Carbon(LOI)
	Ideal 3% 4.23

Field ID: FOLKINGHAM GRASS	
An Ideal soil structure (Bd)	
1.4	
ph & CEC	Active pH
	8.60
	pH is restricting nutrient availability.
FALSE	
FALSE	
OM	Buffer pH
	7.70
	Active Carbon mg & %
271 0.63%	
OM	Organic Matter
	Min >3% 7.80
OM	Organic Carbon(LOI)
	Ideal 3% 4.58

This soil was tested after the remedial action, and we can see a good direction of travel. The pH is dropping, the organic matter is rising, and the C:N ratio is stabilising. Sulphur is still elevated but will drop as the pH falls.

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Testing the soil biology: PLFA analysis

Phospholipid Fatty Acid 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.

Results	Unit	Result	low	rather low	average	rather high	high
Biological							
Microbial biomass	mg PLFA/kg	25					
Total bacteria	mg PLFA/kg	22					
Gram positive	mg PLFA/kg	10					
Actinomycetes	mg PLFA/kg	2,9					
Gram negative	mg PLFA/kg	13					
Total fungi	mg PLFA/kg	2,6					
Arbuscular Mycorrhiza	mg PLFA/kg	1,4					
Other fungi	mg PLFA/kg	1,2					
Protozoa	mg PLFA/kg	0,16					
Shannon Wiener Index		1,28					
Fungal/bacterial ratio		0,8					
Gram(+)/Gram(-) ratio		0,8					
Physical							
Acidity (pH)		7,0					
C-organic	%	2,68					
Organic matter	%	4,5					
SOC/SOM ratio		0,60					
Clay (<2 pm)	%	49					

Results	Unit	Result	low	rather low	average	rather high	high
Biological							
Microbial biomass	mg PLFA/kg	< 0,6					
Total bacteria	mg PLFA/kg	< 0,6					
Gram positive	mg PLFA/kg	< 0,3					
Actinomycetes	mg PLFA/kg	< 0,2					
Gram negative	mg PLFA/kg	< 0,3					
Total fungi	mg PLFA/kg	< 0,2					
Arbuscular Mycorrhiza	mg PLFA/kg	< 0,1					
Other fungi	mg PLFA/kg	< 0,1					
Protozoa	mg PLFA/kg	<0,03					
Shannon Wiener Index		< 1,60					
Fungal/bacterial ratio		<1,2					
Gram(+)/Gram(-) ratio		<1,0					
Physical							
Acidity (pH)		10,5					
C-organic	%	2,02					
Organic matter	%	5,2					
SOC/SOM ratio		0,39					
Clay (<2 pm)	%	45					

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

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

Organic matter Figure: Quality of the organic matter



Organic carbon held in micro-organisms
Microbial biomass

mg C/kg
529

Organic matter Figure: Quality of the organic matter



Organic carbon held in micro-organisms
Microbial biomass

mg C/kg
< 18

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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

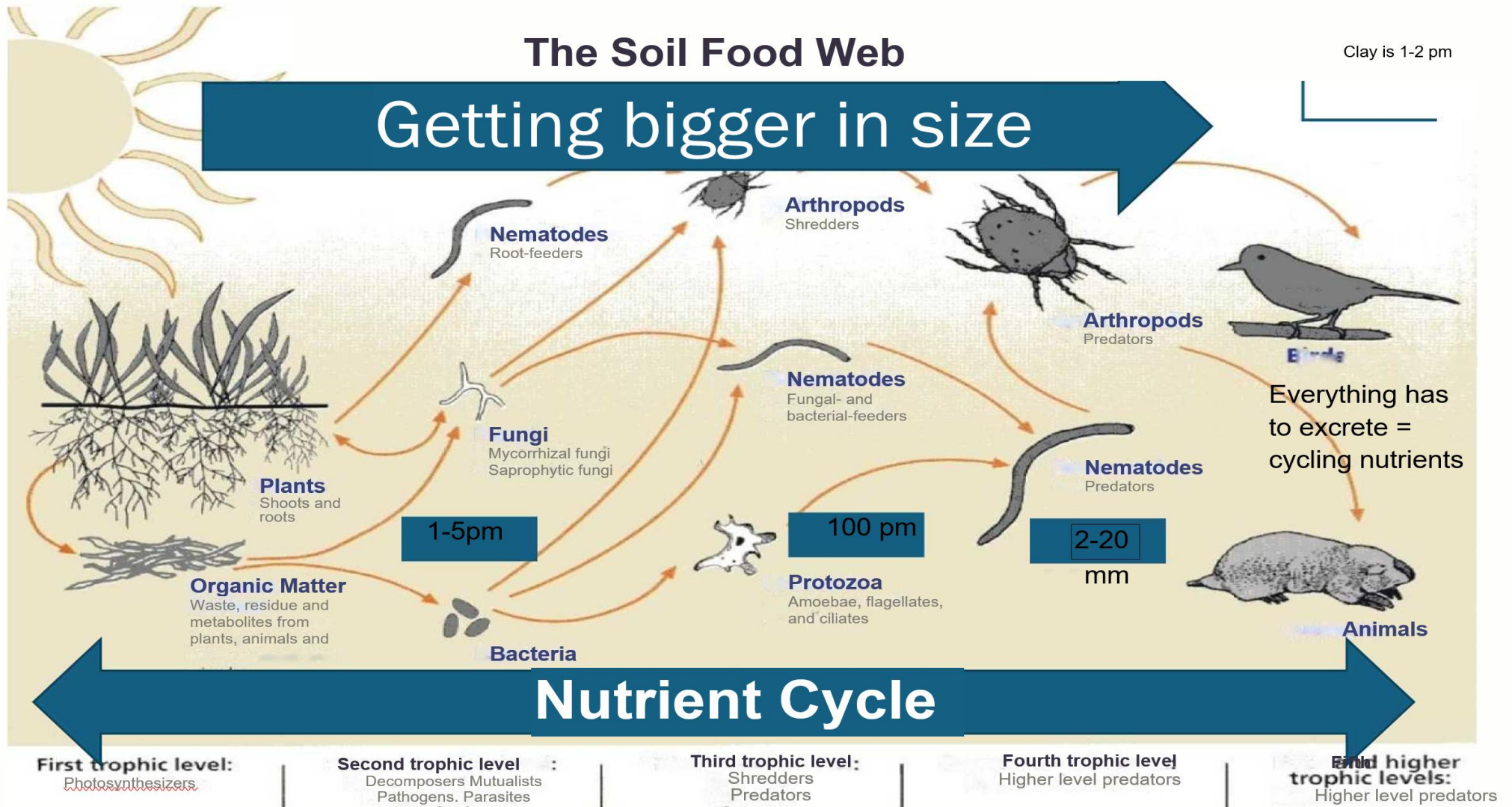
Co2 Burst	4	Total Carbon (Dum)	2.6
		Total N (Dum)	0.12
		SOC/Clay	
C:N ratio	21.67	Guide	12
			11.2

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Stabilisation of Haul Road Track with 3% CEMI

Haul Road Compaction to >30% CBR



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Pulverisation using a Stabilisation Mixer to re-structure the stabilised soil



Samples taken for Gold Testing



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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 DECOMSTRAT are determined by the TerraMap GOLD Test Analysis

Field ID:	FIELD	1 Ha	CROP SOWN:	No Crop Given
Ideal structure (8d)	1.4	Priority, consider liming.	Soil test is assumed to be carried out for soil at	General plough depth
Active pH	6.20	Result	9.77	Sand % 50 Silt % 23 Clay % 27
Buffer pH	6.90	Total Exchangeable Capacity (p.p.m.)	105	Co2 Burst Index
Active Carbon M %	643	Co2 Burst Index	0	Dry BD 1131
Organic Matter	Min 5% 6.10	Maintain Organic good matter levels	105	Estimate 18 kg of NP from OM
Organic Carbon	Min required OM for structural integrity 3	3.58	10.5	70 TCHs
Min required OM for structural integrity	3	3.58	10.5	70 TCHs
pH	6.20	Soil management recommendations	consider crop peak demands	Foliar management recommendations
Calcium	2572	2731	159	355.9 Kghs K2O Fertiliser
Magnesium	286	157	-129	355.9 Kghs K2O Fertiliser
Potassium	293	297	4	355.9 Kghs K2O Fertiliser
Sodium	39	21	-18	355.9 Kghs K2O Fertiliser
Phosphates	69	115	16	355.9 Kghs K2O Fertiliser
Sulphates	69	115	16	355.9 Kghs K2O Fertiliser
Major Elements in Elemental form	kg/ha DESIRED	kg/ha Found	Difference	kg/ha Found
Calcium (Ca)	2572	2731	159	355.9
Magnesium (Mg)	286	157	-129	355.9
Potassium (K)	293	297	4	355.9
Sodium (Na)	39	21	-18	355.9
Other elements	7%	3.0	Minor Importance	7.17
Hydrogen	8%	3.0	Minor Importance	7.17
Sulphate (S)	69	115	16	355.9
Phosphate (P2O5)	69	115	16	355.9
Electrical Conductivity	0.07	0.07	0.00	0.07
Total Dissolvable Salts	0.07	0.07	0.00	0.07
EC/TDS	0.07	0.07	0.00	0.07
Phosphorus	1.6	1.6	0.00	1.6
C:P ratio	24	24	0.00	24
pH	6.20	6.20	0.00	6.20
Organic Carbon	3.58	3.58	0.00	3.58
Predicted availability of trace elements	Found	Found	Found	Found
Boron	1.30	1.30	1.24	1.30
Iron	mg/l	337.00	18-189	337.00
Manganese	mg/l	29.10	18-70	29.10
Copper	mg/l	3.90	2.5-7	3.90
Zinc	mg/l	4.60	4-10	4.60
Chlorine	mg/l	26.00	9-20	26.00
Iodine	mg/l	0.00	1	0.00
Molybdenum	mg/l	1.50	0.5-0.7	1.50
Cobalt	mg/l	0.30	0.5-2	0.30
Standard UK Index to ISO/IEC 17025-2005	Index	Index	Index	Index
29	3	3	3	3
178	2-	2-	2-	2-
87.6	2	2	2	2
UK phosphate is via the Olsen method	Organic Matter	6.1	Organic Matter	0
2.0	Standard testing method for Southern Ireland	Standard testing method for Southern Ireland	Standard testing method for Southern Ireland	Standard testing method for Europe

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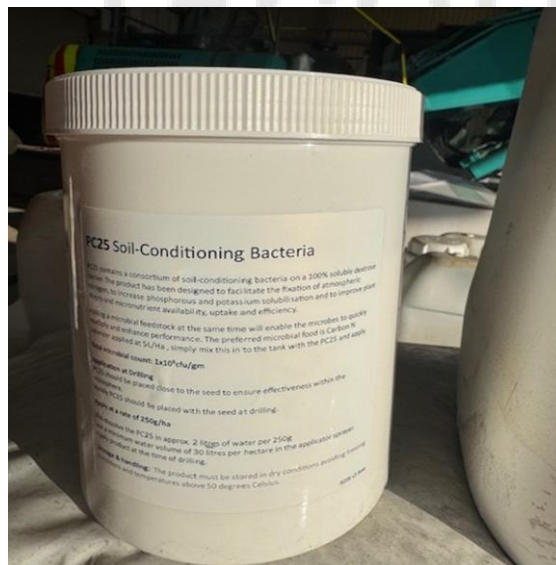
Re-Balancing pH and Nutrients

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

Soil Conditioning Bacteria and Huma-Grow are applied to redress the nutrient loss caused by stabilisation

Nutrients can leach through the soil profile and enhance the soil fertility

Good topsoil management is the key to successful decommissioning of stabilised works.



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Cover Crop Seeding

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



Cement Stabilised
subsoil



Untreated
subsoil

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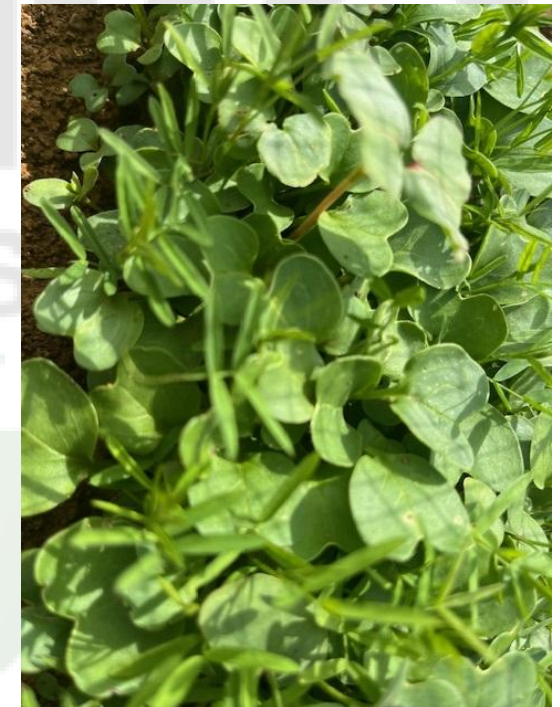
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Regenerative Process

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.



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Six week established growth in the pH balanced pulverised subsoil.
Fully established root systems and increased organic matter in the pulverised subsoil.



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In summary:

The soil is measured to ascertain its physical, chemical and biological status, and all reinstatement works are designed to restore it to its native state.

These treatments include:

Chemical intervention - pH and humic acids,

Physical - Pulverisation

Biological - Plant roots and biological inoculants.

Organic - Wild Flower Planting

All targeted via the TerraMap digital mapping system, Gold Standard Analysis and PLFA Analysis.



Haul Road Decommissioned and topsoil fully reinstated

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Testimonial – Norfolk CC Long Stratton By-Pass



Quentin Brogdale <quentin.brogdale@norfc

To: Patrick Furlong

Cc: Anna Skrzynecka; Mark Averill



Reply



Reply All



Forward



Wed 21/01/2026 10:45

You replied to this message on 21/01/2026 10:52.

[Click here to download pictures.](#) To help protect your privacy, Outlook prevented automatic download of some pictures in this message.

Patrick,

From my point of view, your team have done a good job pulverising the stabilised ground at the main Long Stratton bypass compound, producing a consistently graded material

The landowner has seen it and also regards it as a tidy job.

The attention given to the properties of the subsoil, such as pH value and organic compounds, is also very professional.

Overall I am pleased with how you have gone about this and would recommend the process for similar future projects.

Regards

Quen

Quentin Brogdale, Project Manager (Construction) Long Stratton Bypass

| Mobile: 07885 579595 | Working Hours: Tuesday to Thursday 0730 to 1630



Norfolk County Council

