

# **APPENDIX 11**

(Soils and Agricultural Land Classification - Matthews (Sussex) Ltd)



# LAND AT KNEPP CASTLE, WEST GRINSTEAD, WEST SUSSEX SOILS AND AGRICULTURAL LAND CLASSIFICATION

#### **SUMMARY**

In December 2017, an intrusive site investigation was undertaken within two fields (referred to herein as Block A and Block B), on land located to the south of Hill House Farm, Worthing Road, Horsham RH13 8LG. Block A covers approximately 1.9 hectares and Block B covers 3.25 hectares. Block A and Block B form part of the land at Knepp Park of the Knepp Estate, West Grinstead, West Sussex.

The site investigation was conducted in general accordance with BS 5930:2015 Code of Practice for Ground Investigations. This comprised the excavation of a series of trial pits (of dimensions 0.4 metres (m)  $\times$  0.4m) into sub-soils and into the underlying Weald Clay Formation. It was found that most of the soils were within the Weald Clay Formation, with only a thin layer of very clayey and silty top soil. and were subject to extremely poor drainage.

#### **Introduction and Methodology**

This report describes the soils and Agricultural Land Classification (ALC) of approximately 5.15 hectares (12.7 acres) of land at Knepp Park, part of the Knepp Estate, West Grinstead, West Sussex. This soil survey has been undertaken to support the submission of proposals for lake restoration works and landscaping works at Knepp Park.

- The report is supplementary to the initially submitted Appendix S Soils and Agricultural Land Classification Report dated April 2010 and is based on a site inspection carried out on 12<sup>th</sup> December 2017.
- 2. During the site investigation, 10 trial pits were excavated. Their dimensions were 0.4m wide x 0.4m long and were excavated to a depth where the Weald Clay Formation was identified, at depths ranging between 0.25m-0.4m below ground level (bgl).
- 3. Each soil profile was photographed and observed soil layers measured and described. Texture was also assessed using a feel (hand) test.
- 4. Land quality has been assessed using the revised criteria and guidelines for the Agricultural Land Classification system, introduced in 1989.



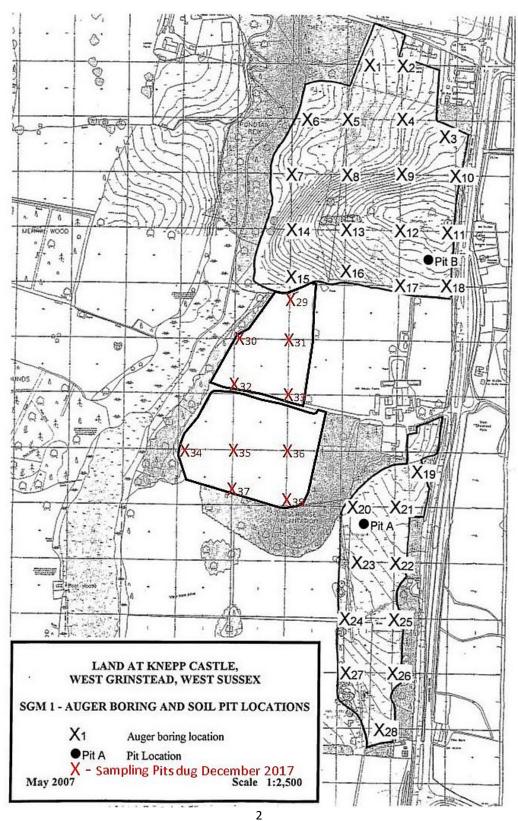




Figure 1: Map of sampling locations with adopted sampling grid

#### **General Description of the Site:**

#### Land Use

- 5. The land investigated consists of two blocks lying to the south of the buildings located at Hill House Farm, situated adjacent to Worthing Road (A24 roadway). At the time of the investigation, the land was used for agricultural purposes, primarily livestock grazing.
- 6. Block A is located in the northern portion of the investigation area and consists of a single fenced grass field, approximately 1.9 hectares in area. It is separated from Block B by a livestock fence and a row of trees. Both Block A and Block B are illustrated on Figure 2.
- 7. Block B, located in the southern portion of the investigation area is also a single fenced off field.



Figure 2: Location of the additional fields tested - Knepp Castle, West Sussex

#### **Site Conditions**

8. At the time of sampling, it was noted that the temperature was approximately 5°C. In the days leading up to the site investigation, there had been a moderate to high amount of precipitation at the site. At the time of the investigation, the ground was very wet with a considerable amount of surface water present. The soil appeared to be very water logged especially in places with a higher percentage of clay.





#### Soils

- 9. Soils are classified as Planosol, formed in the Weald Clay Formation and are heavily textured with very poor drainage.
  - <u>Topsoil</u> texture was clayey silt with predominantly very fine silt particles. No stones were observed. Hand tests revealed a moderate content of clay (poor elasticity). The colour mainly reflected the colour of subsoil Weald Clay Formation with a low percentage of organic matter. Turf roots were typically visible from ground surface to 0.2m bgl. Occasional superficial dark organic layers were observed (in trial pits TP33 and TP35), which were indicated to be the result of manure spreading or grazing as animal excrements were observed in these soils.
  - <u>The Weald Clay Formation</u> showed an occasional mottling which indicates the soils were frequently waterlogged. The base of the clayey layers was not expected to be encountered, given the maximum excavated depth of the shallow pits was approximately 0.40m bgl.

### **Brief Profile Description**

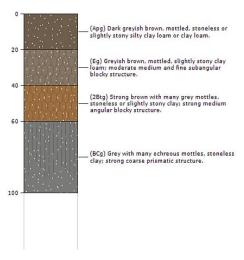


Figure 3: Brief Profile Description of the Reported Geology beneath the Investigation Area



# 10. <u>Trial Pit descriptions:</u>

Trial Pit TP29						
Horizon	Depth (cm.)	Description				
Apg	0-8	Very moist, grey to light black, sticky and non-plastic silty clay with a moderate fine to medium granular structure; medium packing density; common very fine and fine roots; diffused boundary.				
Eg	8-35	Greyish brown, mottled, smooth clay loam; Moderate medium and fine subangular blocky structure.				
2Btg	35 +	Moist, bright yellowish grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.				

During excavation, poor permeability and poor drainage of the soils was observed with streams of surface water rushing into the pit, which were not able to infiltrate the clayey topsoil.



Figure 4: Trial Pit TP29



Trial Pit TP30						
Horizon	Depth (cm.)	Description				
Apg	0-5	Very moist, grey to light black, sticky and non-plastic silty clay with a moderate fine to medium granular structure; medium packing density; common very fine and fine roots; diffused boundary.				
Eg	5-25	Greyish brown, mottled, smooth clay loam; Moderate medium and fine subangular blocky structure				
2Btg	25 +	Moist, bright yellowish grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.				

TP30 is presented in Figure 5. Mottling of the soils started at approximately 0.1m bgl, indicating very low permeability and consequently common waterlogged conditions in surface layers. Ponding of surface water was observed during excavation, indicating poor permeability and drainage of the topsoil.



Figure 5: Trial Pit TP30



Trial Pit TP31						
Horizon	Depth (cm.)	Description				
Apg	0-10	Very moist, grey to light black, sticky and non-plastic silty clay with a moderate fine to medium granular structure; medium packing density; common very fine and fine roots; diffused boundary.				
Eg	10-30	Greyish brown, mottled, smooth clay loam; Moderate medium and fine subangular blocky structure				
2Btg	30 +	Moist, bright yellowish grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.				

TP31 is presented in Figure 6. Compared to other trial pits, the infiltration rate was slightly faster, but still very poor permeability and drainage were noted during the excavation.



Figure 6: Trial Pit TP31



Trial Pit TP32						
Horizon	Depth (cm.)	Description				
Apg 0-20		Very moist, greyish brown, mottled, smooth, sticky and non-plastic sill clay with a moderate fine to medium granular structure; medium pack density; common very fine and fine roots; diffused boundary.				
Ax	20-25	Rich dark organic layer, possibly an old manure deposit.				
2Btg	25 +	Moist, bright yellowish grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.				

TP32 is presented in Figure 7. Mottling of the soils was observed in surface layers, indicating soils had very low permeability and were waterlogged in surface layers. Poor permeability and drainage were observed especially in the surface layers.



Figure 7: Trial Pit TP32



Trial Pit TP33						
Horizon	Depth (cm.)	Description				
Apg	0-10	Moist, dark brown/black, fibrous with fine, undecomposed plant parts, medium to course granular structure; common very fine and fine roots; clean sharp boundary.				
Eg	10-20	greyish brown, mottled, smooth, sticky and non-plastic silty clay with a moderate fine to medium granular structure; medium packing density; common very fine and fine roots; diffused boundary				
2Btg	20 +	Moist, bright yellowish grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.				

TP33 is presented in Figure 8. A drier soil profile was noted, with a slightly less dense texture overall, with more silt and less clay and a water permeable barrier in the form of the Apg layer.



Figure 8: Trial Pit TP33



Trial Pit TP34						
Horizon	Depth (cm.)	Description				
Apg	0-5	Very moist, grey to light black, sticky and non-plastic silty clay with a moderate fine to medium granular structure; medium packing density; common very fine and fine roots; diffused boundary.				
Eg	5-20	Greyish brown, mottled, smooth clay loam; Moderate medium and fine subangular blocky structure, diffused boundary				
2Btg	20 +	Moist, bright yellowish grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.				

TP34 is presented in Figure 9. Mottling of the soils started at 0.1m bgl indicating waterlogged conditions in surface layers. The surface water and saturated soil profile were observed during the excavation.



Figure 9: Trial Hole TP34



Trial Pit TP35						
Horizon	Depth (cm.)	Description				
Apg	0-8	Very moist, grey to light black, sticky and non-plastic silty clay with a moderate fine to medium granular structure; medium packing density; common very fine and fine roots; diffused boundary.				
Eg	8-25	Greyish brown, mottled, smooth clay loam; Moderate medium and fine subangular blocky structure				
2Btg	25 +	Moist, bright yellowish grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.				

TP35 is presented in Figure 10. Soil mottling started at 0.08m bgl which indicated a very low permeability and periodic waterlogged conditions in the surface layers. Puddles of surface water were observed during excavation, indicating poor permeability and drainage of the trial pit soils.



Figure 10: Trial Hole TP35



	Trial Pit TP36						
Horizon	Depth (cm.)	Description					
Apg	0-9	Very moist, grey to light black, sticky and non-plastic silty clay with a moderate fine to medium granular structure; medium packing density; common very fine and fine roots; diffused boundary.					
Eg	9-38	Greyish brown, mottled, smooth clay loam; Moderate medium and fine subangular blocky structure					
2Btg	38 +	Moist, bright yellowish-grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.					

TP36 is presented in Figure 11. Soil mottling started at 0.1m bgl which indicated very low permeability and periodic waterlogged conditions in surface layers. Surface water was observed to pool on the ground, indicating poor permeability and drainage of the trial pit soils during the excavation.



Figure 3: Trial Hole TP36



Trial Pit TP37						
Horizon	Depth (cm.)	Description				
Apg	0-6	Very moist, grey to light black, sticky and non-plastic silty clay with a moderate fine to medium granular structure; medium packing density; common very fine and fine roots; diffused boundary.				
Eg	6-20	Greyish brown, mottled, smooth clay loam; Moderate medium and fine subangular blocky structure				
2Btg	20+	Moist, bright yellowish-grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.				

TP37 is presented in Figure 12. Soil mottling started at 0.15m bgl indicating a very low permeability and periodic waterlogged conditions in surface layers. Puddles of surface water were observed during the excavation.



Figure 4: Trial Hole TP37



	Trial Pit TP38						
Horizon	Depth (cm.)	Description					
Apg	0-9	Very moist, grey to light black, sticky and non-plastic silty clay with a moderate fine to medium granular structure; medium packing density; common very fine and fine roots; diffused boundary.					
Eg	9-38	Greyish brown, mottled, smooth clay loam; Moderate medium and fine subangular blocky structure					
2Btg	38 +	Moist, bright yellowish-grey, firm, sticky and very plastic clay with a medium to coarse angular blocky structure; medium packing density; moderately firm, dark reddish brown concretions (mottling); few fine roots; diffused boundary.					

TP38 is presented in Figure 13. Soil mottling started at 0.1m bgl, indicating periodic waterlogged conditions in the surface layers. Puddles of surface water were observed during the excavation.



Figure 5: Trial Hole TP38

#### **Loam Subsoils**

11. The soils descriptions indicate there is between 0.1m and 0.29m of recognisable loamy subsoil but it is of limited distribution beneath the 5.15 ha of Block A and Block B.



- 12. Beneath Block A, the loamy soils were absent from trial pit 32; the loam soil was between 0.10m and 0.27m thick at trial pit locations TP33 and TP29 respectively.
- 13. In Block B, the loam thins from the east beneath the field, from 0.29m in trial pits TP36 and TP38 towards the west, where it was observed at thicknesses between 0.14m and 0.17m in trial pits TP37 and TP35 respectively.

#### **Analytical Results**

- 14. The soils from each of the ten trial pits were sampled between ground level and 0.30m bgl, placed in dedicated appropriate laboratory containers and sent to an UKAS and MCERTS accredited laboratory for analysis.
- 15. The analytes tested for included: pH, total nitrogen, phosphorus, potassium, magnesium, sodium, copper, nickel and zinc. The analytical laboratory certificates are presented at Appendix A.
- 16. The analytical results for the topsoil and near sub-soils from each sampling location indicate the presence of compounds expected to naturally occur in agricultural soils and proportionately low levels i.e. <50mg/kg, of copper, nickel and zinc, for the current land use.

#### **Agricultural Land Classification**

- 17. This assessment supports the Agricultural Land Classification Report classification provided in 1:63360 provisional ALC map (Sheet 182) as undifferentiated Grade 3. The ALC Report also notes that grade 3 examples are "very low in the grade range" and the soils assessed in this investigation are to be graded as Subgrade 3b.
- 18. Under the revised ALC criteria, even the wettest and heaviest of the clayey Planosols, developed directly over the Weald Clay Formation with little or no superficial drift can be graded no lower than Subgrade 3b. This is the sub-classification applicable for the soils in Blocks A and B of this investigation, due to the combination of poor drainage (characterised as Wetness Class IV) and heavy, clay rich topsoil textures.
- 19. The ALC gradings are as follows:

Grade	Block A North		Block B South		Land surveyed	
	ha	%	ha	%	ha	%



3b	3.25	100	1.9	100	5.15	100	
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20. The soils descriptions indicate there is between 0.1m and 0.29m of recognisable subsoil but it is of limited distribution beneath the 5.15 ha of Block A and Block B.



### **REFERENCES**

Geological Survey, Sheet 302 (Horsham), 1:50,000

Geological Survey, Sheet 318 (Brighton), 1:50,000

Soil Survey of England and Wales, National Soil Map, Sheet 6 (South East England), 1:250,000 and accompanying Regional Bulletin.

Agricultural Land Classification, Sheet 182 (Brighton and Worthing) 1:63,360 and accompanying Report.

Agricultural Land Classification of England and Wales (1988) Revised guidelines and criteria for grading the quality of agricultural land.

The Meteorological Office Climatological data for Agricultural Land Classification (January 1989).



# **APPENDIX A**

# Analytical Certificates for Trial Pit Soil Samples 13<sup>th</sup> December 2017





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# <u> Analytical Report Number : 17-70999</u>

Project / Site name: Kitepp Castle Samples received on: 13/12/2017

Your job number: Samples instructed on: 13/12/2017

Your order number: Analysis completed by: 22/12/2017

**Report Issue Number:** 1 **Report issued on:** 22/12/2017

Samples Analysed: 10 soil samples

Signed:

Jordan Hill Reporting Manager

For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting leachates - 2 weeks from reporting waters - 2 weeks from reporting asbestos - 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.





Analytical Report Number: 17-70999 Project / Site name: Kitepp Castle

Lab Sample Number	877533	877534	877535	877536	877537			
Sample Reference	29	30 None Supplied 0.00-30.00 13/12/2017	31 None Supplied 0.00-30.00 13/12/2017	32	33 None Supplied 0.00-30.00 13/12/2017			
Sample Number Depth (m) Date Sampled Time Taken				None Supplied 0.00-30.00 13/12/2017		None Supplied		
						0.00-30.00 13/12/2017		
							1000	1015
				Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status	
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	20	18	16	19	18
Total mass of sample received	kg	0.001	NONE	1.7	1.7	0.45	2.0	0.44
General Inorganics								
pH	pH Units	N/A	NONE	6.3	6.7	5.6	6.1	6.2
Electrical Conductivity (CaSO <sub>4</sub> extract)	μS/cm	10	NONE	1500	1500	1700	1600	1900
Total Nitrogen (Kjeldahl)	mg/kg	5	NONE	940	670	400	670	1100
Mass Loss on Ignition	%	0.1	NONE	4.0	3.5	2.6	3.3	5.1
Phosphorus (available)	mg/l	1	NONE	22	17	10	17	59
Potassium (available)	mg/l	1	NONE	159	66.9	114	71.6	806
Magnesium (available)	mg/l	1	NONE	130	130	220	120	190
Sodium (available)	mg/l	1	NONE	27	29	37	33	44
Sodium (exchangeable %)	%	0.1	NONE	1.5	1.3	1.0	1.5	1.5
Heavy Metals / Metalloids								
Copper (aqua regia extractable)	mg/kg	1	MCERTS	11	12	6.6	11	14
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	15	14	13	19	11
Zinc (agua regia extractable)	mg/kg	1	MCERTS	59	45	50	67	53





Analytical Report Number: 17-70999 Project / Site name: Kitepp Castle

Lab Sample Number	877538	877539	877540	877541	877542			
Sample Reference	34 None Supplied 0.00-30.00 13/12/2017	35 None Supplied 0.00-30.00 13/12/2017	36 None Supplied 0.00-30.00 13/12/2017	37	38 None Supplied 0.00-30.00 13/12/2017			
Sample Number				None Supplied				
Depth (m) Date Sampled Time Taken				0.00-30.00 13/12/2017				
						1115	1130	1145
				Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status	
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	25	17	17	19	19
Total mass of sample received	kg	0.001	NONE	0.54	0.46	0.39	0.43	0.44
General Inorganics								
pH	pH Units	N/A	NONE	7.0	6.8	6.8	7.0	6.9
Electrical Conductivity (CaSO <sub>4</sub> extract)	μS/cm	10	NONE	1600	1600	1700	1600	1400
Total Nitrogen (Kjeldahl)	mg/kg	5	NONE	650	610	410	700	470
Mass Loss on Ignition	%	0.1	NONE	3.4	3.7	2.7	3.8	2.8
Phosphorus (available)	mg/l	1	NONE	16	19	19	34	15
Potassium (available)	mg/l	1	NONE	115	147	219	494	223
Magnesium (available)	mg/l	1	NONE	190	160	220	210	200
Sodium (available)	mg/l	1	NONE	33	26	26	50	22
Sodium (exchangeable %)	%	0.1	NONE	0.9	0.8	0.8	1.5	0.6
Heavy Metals / Metalloids								
Copper (aqua regia extractable)	mg/kg	1	MCERTS	15	9.0	9.3	12	10
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	14	17	9.3	12	11
Zinc (agua regia extractable)	mg/kg	1	MCERTS	54	58	43	60	49





#### Analytical Report Number : 17-70999 Project / Site name: Kitepp Castle

\* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
877533	29	None Supplied	0.00-30.00	Light brown clay and sand with vegetation.
877534	30	None Supplied	0.00-30.00	Light brown clay and sand with vegetation.
877535	31	None Supplied	0.00-30.00	Light brown clay and sand with vegetation.
877536	32	None Supplied	0.00-30.00	Light brown clay and sand with vegetation.
877537	33	None Supplied	0.00-30.00	Light brown clay and sand with vegetation.
877538	34	None Supplied	0.00-30.00	Light brown clay and sand with gravel and vegetation.
877539	35	None Supplied	0.00-30.00	Light brown clay and sand with vegetation.
877540	36	None Supplied	0.00-30.00	Light brown clay and sand with vegetation.
877541	37	None Supplied		Light brown clay and sand with vegetation.
877542	38	None Supplied	0.00-30.00	Light brown clay and sand with vegetation.





Analytical Report Number: 17-70999 Project / Site name: Kitepp Castle

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Carbon to Nitrogen Ratio (Topsoil - BS3882:2015)	Carbon to Nitrogen ratio (:1) calculated using Loss on Ignition.	BS3882:2015	L01TS2015	W	NONE
Carbonate (Topsoil - BS3882)	Determination of Carbonate as per BS 3882:2015.	BS3882:2015	L01TS2015	D	NONE
Conductivity (BS3882/BS8601)	Determination of the conductivity of soil in accordance with BS 3882:2007 methodology	BS3882:2007 & BS8601:2013	L01TS	D	NONE
Extractable/Available Metals (BS3882/BS8601)	Determiation of the extractable metals in soil, in accordance with BS3882:2007 methodology.	BS3882:2007 & BS8601:2013	L01TS	D	NONE
Kjeldahl nitrogen in soil	Determination of total nitrogen using the Kjeldahl- digestion method and colorimetric determination.	In house method based on BS 7755- 3.7:1995 &	L087-PL	D	NONE
Mass loss on ignition (Topsoil - BS3882)	Determination of Loss on Ignition as per BS 3882:2015.	BS3882:2015	L01TS2015	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Nitrogen (TKN)	Determination of total nitrogen by Kjeldahl method.	BS3882:2007	L087-PL	D	NONE
pH (BS3882/BS8601)	Determination of the pH of soil in accordance with BS 3882:2007 methodology	BS3882:2007 & BS8601:2013	L01TS	D	NONE
Phosphorus as PO4 (BS3882/BS8601)	Determiation of the extractable phosphorus in soil, in accordance with BS3882:2007 methodology.	BS3882:2015 & BS8601:2013	L01TS	D	NONE
Sodium (exchangeable %)	Determination of exchangeable sodium (%) by calculation, in accordance with BS3882:2007 methodology.	BS3882:2007	L087-PL	D	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.