

National Soil Resources Institute: Information paper

Data Extraction from the
National Soils Inventory for
Agricultural Land Classification



Data Extraction from the National Soils Inventory for Agricultural Land Classification

Copyright © Cranfield University, 2010

Dr R J A Jones, M E Proctor and J. M. Hollis

Contact: nsridata@cranfield.ac.uk www.landis.org.uk

1. Introduction

This report describes the extraction and manipulation of soil data from the National Soil Inventory (NSI) databases held in NSRI's Land Information System LandIS. The data are required for reclassifying the land at each NSI 5km grid intersection in England and Wales using the revised Agricultural Land Classification (ALC) of the Ministry of Agriculture, Fisheries and Food (MAFF 1988). The data are needed for the purpose of assessing the degree of change in the classification of agricultural land over the period since the original ALC surveys were undertaken (1960's and 1970's). Table 2.1 lists the parameters supplied for the determination of ALC.

The extraction work and subsequent data manipulation have been done under contract to the Resource Planning Team (RPT) of ADAS, formerly part of MAFF (now Defra), who have undertaken the reclassification of the NSI sites under a separate contract with MAFF (now Defra).

This report describes the National Soil Inventory project, particularly the field survey programme, and provides the necessary background to the data supplied from the NSI databases for this study. The data were passed to RPT, ADAS, in early December 1993 so that the reclassification work could be completed in the current financial year - ending 31-Mar-94. The information provided here is intended to support the main findings of the RPT in their report to MAFF (now Defra).

1.1 *Field Survey for the National Soil Inventory*

Field work for the National Soil Inventory was conducted between 1979 and 1983 and integrated as far as possible with survey work for the 1:250,000 National Soil Map. This section describes the procedure for locating sites for the inventory, and for recording and sampling the soil at those sites.

1.1.1 **The Target Population**

The NSI contains information about soil that is or can be used for growing crops, pasture or forest. It includes:

- All land currently used for agriculture, forestry, horticulture, and fruit growing.
- All wild land, e.g. saltmarsh, mountain and bog.
- Open amenity land, such as commons and golf courses.
- Grossly disturbed land, reclaimed land and 'made' land.
- Former hedgerows and other forms of field boundary, ditch and river margins where dredgings have been placed.
- Land close to gates and farm yards. (Sites occurring on such land are atypical, but they form part of the total productive land, giving an unbiased picture of the soil of England and Wales).

1.1.2 Sampling scheme

The sites visited occur at regular 5km intervals at principal 1km intersections on the National Grid of the Ordnance Survey, four per 100km² or 1:25,000 scale map sheet. The origin of the sampling grid is 1km East and 1km North of the National Grid origin so that the sampling points on each 1:25,000 map sheet are inset 1km and 6km East and North of the South-West corner of the map. This was to facilitate field survey.

1.1.2.1 Finding Sites

Although the exact location of all sampling points is defined as above, it was not necessary to find the sites accurately, provided bias was avoided. Location accurate to 20m on enclosed land and to 50m or even 100m on open land was the declared reasonable aim. The following procedure was recommended for finding sites:

- Choose from the map (or air photograph) some easily recognisable feature near the grid point, and go there. Estimate from the map the direction and distance to the grid point. Then, using either a compass or some other means of siting to give direction, pace out the distance. Then stop, dig, and describe and sample the soil profile.
- Do not look around for 'typical', convenient or pleasant places to dig, and do not shorten or lengthen pace to avoid any kind of ground. If uncertain, then use a tape or chain to measure the last 10m or 20m. On moorland it might be necessary to find sites by resection.

1.1.2.2 Deviations

Where the soil at a grid intersect was inaccessible, or where there was no soil there, (rock or water), the following procedure was followed:

1. The reason for not being able to observe the soil **at the 5km grid point** was recorded.
2. A substitute site 100m to North was chosen. If the soil there was inaccessible, then a site 100m East, or South or West, in that order, was chosen. If that failed to give access, then the process was repeated at 200m distance. If that also failed, then the process was repeated at 400m distance. Finally, if that also failed, then the site was abandoned.
3. The true grid reference of the **substitute**, not the original intersect, was recorded. The computer was programmed to recognise the latter.
4. In large urban areas where inaccessibility could be inferred from the OS map or air photography, only the grid reference, observer's initials, reason for non-access, and '0' in the box for number of horizons (Figure 1) were recorded.

FIGURE 1. Proforma for recording NSI data.

1 Map reference 10

11 15 Date 21 Observer 25 Series 37 Subgroup 41

42 Day 47 Month Year Initials 55 61 m ft 67 (°) Aspect No. horizons Form

0 8 5 0 0 Project Soil inaccessible at grid point Made Reclaimed Elevation Slope

11 15 Rock % outcrop 20 Rock type Calc 33 Erosion Depn. 41 L C C

44 Land use/vegetation Litter (cm) Spare

11 Depth 15 Matrix 21 Main mottles 31 Class 35 size shape

42 Designation 47 Colour 53 Hue val chr Abund Size 63 Particles size 67 Peds

11 Depth 15 Water 18 Porosity 23 Roots 29 OM 31 Nature of O 35 36 distinctness

41 Type Calc Abund Size Type Ab Size 58 Carbonate % 63 Type Ab Coats Abund 71 L Boundary Form

11 Depth 15 Matrix 21 Main mottles 31 Class 35 size shape

42 Designation 47 Colour 53 Hue val chr Abund Size 63 Particles size 67 Peds

11 Depth 15 Water 18 Porosity 23 Roots 29 OM 31 Nature of O 35 36 distinctness

41 Type Calc Abund Size Type Ab Size 58 Carbonate % 63 Type Ab Coats Abund 71 L Boundary Form

11 Depth 15 Matrix 21 Main mottles 31 Class 35 size shape

42 Designation 47 Colour 53 Hue val chr Abund Size 63 Particles size 71 Peds

11 Depth 15 Water 18 Porosity 23 Roots 29 OM 31 Nature of O 35 36 distinctness

41 Type Calc Abund Size Type Ab Size 58 Carbonate % 63 Type Ab Coats Abund 71 L Boundary Form

11 15 22 29 SAMPLES

Size XF = extremely fine VF = very fine F = fine M = medium C = coarse VS = very small S = small L = large VL = very large B = boulders
Abund. O = none F = few C = common M = many A = abundant VM = very many XA = extremely abundant

1.1.3 Observation and Recording

For the inventory, small pits were dug to 80 cm and the soil inspected by auger to 120cm in the bottom of the pit where possible. Properties recorded are given on the NSI recording proforma (Figure 1) , and with a few exceptions the definitions follow the Soil Survey Field Handbook (Hodgson, 1976).

1.1.3.1 The Proforma

The new proforma was designed so that:

1. it could be completed in the field;
2. it was readable in the office;
3. the data it bears could be punched for computer without transcription.

Its layout is self-evident.

The proformas were filled in as neatly as circumstances allowed using blue or red pen, rather than black. Characters were written boldly, and the digits 0, 1 and 2 firmly distinguished from the letters O, I and Z.

1.1.3.2 Codes

Numeric codes have been replaced by mnemonic alphabetic codes for all properties except date and soil sub-group; for example SL for sandy loam, SST for sandstone. For size and abundance, commonly-used alphabetic mnemonic codes were used, and listed on the proformas. Most other properties were recorded by placing a tick (✓) in the appropriate box. The abbreviations in the boxes were clear. Soil series and the type of rock and stones were not coded. Details for each property are given below.

Map reference. Entered as the two letters of the 100km x 100km National Grid square, followed by the three-digit Easting and three-digit Northing (OS standard to the nearest 100m). Zeroes for the 10m referencing are dotted. If after digging a pit a surveyor discovered that it was not where he thought and was off the 100m grid, the zeroes could be overwritten with correct values to 10m to identify the exact location.

Date: Day, month, year, in that order.

Observer: Initials.

Series: Name, left justified, up to 12 characters

Sub-group: Code, without decimal point.

<i>Number of horizons:</i>	Number of soil layers or horizons was recorded. (This was important for data validation.)
<i>Soil inaccessible at grid point:</i>	<p>The reason was ticked. The abbreviations are:</p> <p>Urb = Urban — towns, villages, suburbs, factories, docks.</p> <p>RB = Rural Building — isolated houses, cottages, farm buildings, mills, public roads, railways</p> <p>Min tip = Mines, tips — all land occupied by mine workings including tip and open-cast, quarries, clay pits, gravel pits and their waste; town refuse.</p> <p>Fd Bdy = Field Boundary — wall, bank, hedge, or metalled farm track.</p> <p>Rok = Rock — bare rock at the surface.</p> <p>Wat = Water — lake (artificial or natural), river, canal.</p> <p>Oth = Other.</p> <p>Acc ref = Access refused.</p>
<i>Made land:</i>	<p>Urb = Urban — town refuse, factory waste, building rubble.</p> <p>Min = Mining, colliery</p> <p>Oth = Other</p>
<i>Reclaimed land:</i>	<p>Urb = Urban — land previously occupied by houses, factories, railway yards.</p> <p>Min = Mining, — land from which coal or other minerals have been extracted by open-cast methods and which has later been restored.</p> <p>Oth = Other.</p>
<i>Elevation:</i>	Recorded either in metres or feet, the m or ft box being ticked as appropriate.
<i>Slope:</i>	The gradient in degrees from 10m above site to 10m below site and aspect, either as compass point or azimuth angle in degrees clockwise from North = 0. Form should be ticked.
<i>Rock:</i>	Only the leftmost box that applies for abundance should be ticked, and rock name entered, up to 12 characters, left justified. The common abbreviations SANDST, SST or SDST may be used for sandstone, and LST for limestone. Box headed 'Calc' may be ticked if rock is calcareous. The tick may be omitted for limestone and chalk.

<i>Erosion:</i>	Tick as appropriate based on evidence within 10m of pit.
<i>Land capability:</i>	Record class and sub-class.
<i>Land Use/ Vegetation:</i>	Tick. Classes are as in the Soil Survey Field Handbook (Hodgson 1976), except: Arab = Arable — includes all arable forms of land use. Amty = Amenity — includes all open amenity land.
<i>Litter:</i>	Thickness in cm recorded.
<i>Spare:</i>	Use and definitions to be provided. Necessary for validation in computer.
<i>Horizon designation:</i>	Enter judgment based on field evidence. Use first box for b or numerical prefix only. The second and third boxes are for the main letter, e.g. A, B, C, etc. and left justified if there is only one letter. The fourth and fifth boxes are for lower-case suffixes, again left justified.
<i>Colours:</i>	Enter Munsell codes, omitting decimal points. Record abundance and size of mottles using codes printed.
<i>Particle size:</i>	Record using conventional mnemonics as follows: S = sand Z = silt C = clay LS = loamy sand ZL = silt loam SC = sandy clay SL = sandy loam SZL = sandy silt loam CL = clay loam ZCL = silty clay loam ZC = silty clay PT = peat LPT = loamy peat SPT = sandy peat Right justified in right-hand three boxes. Left-hand box is used to record whether sand fraction is fine (F) or coarse (C). Field estimates of clay and silt percentage entered.
<i>Structure:</i>	Size of peds (codes given) entered and shape and grade ticked.
<i>Water state</i>	Tick dry, moist (mst) or wet
<i>Porosity</i>	Tick appropriate class, eg VSP for very slightly porous

<i>Roots:</i>	Type: enter abundance and size as codes.
<i>Organic matter:</i>	'l' or 'h' for mineral horizons. Tick nature of O if organic.
<i>Coats:</i>	Abundance recorded.
<i>Lower Boundary:</i>	Distinctness and shape.
<i>Stones:</i>	Name of type and sub-type as for Rock. Abundance and size recorded using printed codes. If the same stone type recurred in the second and third horizons, 'repeat' was written in the space provided instead of printing the rock name.
<i>Carbonate:</i>	Tick appropriate box.
<i>Nodules:</i>	Tick type and enter code for abundance.
<i>Missing data:</i>	When it was impossible to observe the properties listed, especially for horizons examined by auger, the relevant sections of the proforma were left blank. For properties such as mottles, roots, nodules, stones where abundance was recorded as '0', the relevant section of the proforma were also left blank. '0' for abundance was entered if there were none. 'N' no entered as previously, except for Munsell hue, for which it is standard practice when the chroma is zero.

1.1.4 Samples

Apart from the bulk topsoil sample (see below), soil could be taken from any part of the pit for laboratory analysis. This fact was recorded by completing the section at the bottom of the proforma. The samples were numbered serially, starting with '1' in the box headed 15, followed by the upper and lower depth limits; then '2' in the box headed 22, and so on.

1.1.5 Data recording: Justification

Numeric values and mnemonic codes were entered right justified in their respective fields, which were separated either by spaces or by heavy lines. Leading zeroes in numeric values could be omitted; thus the month of June might be recorded as '6' rather than '06'. Names for rock and soil series were left justified. Spaces were inserted in names to make them readable. Horizon designation was left justified as described.

1.1.6 Completion of forms

If fewer than three horizons were recorded, the unused lower parts of the form were scored through. Similarly, if the soil was inaccessible, all

horizon sections and the third and fourth rows of boxes for site were scored through.

If more than three horizons were observed, then a second proforma was used, the map reference entered afresh, first scoring through the section for site, and the remainder of the form completed for horizons 4, 5 and 6 as necessary. Again, unused sections were scored through. The number of horizons described was checked and entered on the first card. Finally, the two proformas were stapled together before sending for computer input.

1.1.7 Bulk sample

A bulk sample of the topsoil from around each pit was taken for determination of organic matter and pH, and a range of chemical properties including trace elements (McGrath & Loveland, 1992).

Using a 2.5cm diameter mild steel screw auger, 25 cores were taken from the surface of the soil to 15cm. The surface in this context is the zero of measurement, i.e. excluding living vegetation and litter (L layers) — see Page 14 of the Soil Survey Field Handbook (Hodgson, 1976). The soil was put into a polythene bag and labelled with a B (meaning bulk sample), and the grid reference.

The cores were taken at approximately 4m intervals within a 20m x 20m square, normally with the pit at its centre. These cores were bulked in the field. The target mass of sample was 450g of air-dried material. If necessary, for instance in very organic, loosely packed or very stony soils, the coring exercise was repeated at 1m offsets from the original sampling positions until sufficient material was collected. At the central point of the sampling square, the pit was dug to 80cm, and the soil inspected by auger to 120cm where possible. However, if the pit was close to a field boundary or obvious physiographic boundary, the square was displaced so that only the one field or physiographic unit in which the pit occurred was sampled.

Duplicate samples at one site in every 25 were needed, so an additional bulk sample at every 25th site, again of 25 cores at approximately 4m intervals within the boundaries of the original 4m grid inside the same 20m x 20m square. This second sample was labelled identically to the first.

1.2 Analysis of NSI samples

The analytical work was a joint effort between the Soils and Crop Sciences Division of Rothamsted Experimental Station, the regional soil science and analytical laboratories of the Agricultural Development and Advisory Service (ADAS), and the Soil Survey of England and Wales (now the Soil Survey and Land Research Centre).

In the laboratory, each sample was given a 4-digit acquisition number, allocated in order of receipt of samples rather than by geographical area. This number was used exclusively during the analysis of the

samples, in preference to the 10-digit grid- reference code, so as to minimise data transcription errors.

Full details of sample preparation and analysis are given in McGrath and Loveland (1992). The following sections (1.2.1 to 1.2.3) provide a summary for this report.

1.2.1 Sample preparation and analysis

After collection, samples were transferred to the laboratory and air-dried. Half of each air-dried sample was milled in a mild-steel roller mill to pass a 2mm sieve (Waters and Sweetman, 1956). Preliminary work showed that no detectable contamination by any element of interest arose from this system (Wilkins, pers. comm.). All chemical analyses apart from 'totals' were done on this material without further crushing. The other half of the sample was kept in the unground state as an untouched sample that could be resorted to in cases of contamination at any stage. However, this was never necessary.

1.2.2 Total analyses

A 25g subsample of the <2mm soil was obtained by coning-and-quartering, and ground to <150 μm in an all-agate planetary ball mill, which does not contaminate the samples with any element to be determined. Before any analyses were done, a substantial number of tests were made of various methods that would allow 'near-total' concentrations in soils to be determined. The main requirements of the selected method were:

- i. rapid throughput of samples;
- ii. ability to produce a solution compatible with atomic emission and atomic absorption spectrometry;
- iii. none of the reagents used should present undue danger to laboratory personnel;
- iv. substantial automation of sample treatment;
- v. results as close as possible to those given by absolute methods, given the overriding importance of (i) and (ii) above;
- vi. the solution generated should be suitable for the determination of the maximum number of elements in a single digest;
- vii. applicable to the full range of soil types without problems such as excessive frothing with highly organic or calcareous soil.

Safety considerations ruled out use of hydrofluoric or perchloric acids; and digestion with sulphuric acid gives low recoveries of barium, calcium, lead and strontium due to precipitation as sulphates, as well as running the risk that these could co-precipitate significant amounts of other elements.

Methods using nitric and/or hydrochloric acid were therefore tested and, from the trial results, digestion with *aqua regia* (4:1 hydrochloric:nitric acids by volume) in open glass tubes in large batches using microprocessor-controlled block digesters was chosen (McGrath and Cunliffe, 1985). The method gave similar results to

nitric/perchloric digests, except that results for Cr were greater than when perchloric acid was used.

In particular, the chosen method was compared with two other published methods which use *aqua regia* and reflux condensers (Berrow and Stein, 1983; Colinet et al, 1983). The results for the concentrations of 15 elements in an in-house standard soil obtained by the block digester method and the reflux system of Berrow and Stein (1983) are given by McGrath and Loveland (1992).

In general, the results of the two methods were similar, but it must be noted that the samples were taken to dryness in both cases. When this was not done, as in the published version of the Berrow and Stein method, the concentration of elements in the solutions were smaller than those obtained after open *aqua regia* digest, particularly for Mg, Na and Al. McGrath and Loveland (1992) show that for trace elements, the results of the open tube method ranged from 82-136% of those obtained by the European Community's Bureau of Reference (BCR) *aqua regia* reflux technique for three of their certified reference soils (Colinet et al, 1983). Furthermore, the results of the chosen method fell within 77-120% of the certified total (mass fraction) values, except for Cr in one soil that gave only 53% of the certified value.

McGrath and Loveland (1992) give details of the other analyses undertaken.

1.2.3 Soil pH and organic carbon

The soil pH was measured at ADAS laboratories after shaking 10ml of soil for 15 minutes with 25ml of water. The pH was then measured using a pH meter. Organic carbon was measured at the Soil Survey Laboratories either by loss-on-ignition for soils estimated to contain more than about 20% organic carbon (Avery and Bascombe, 1982), or by dichromate digestion (Kalembasa and Jenkinson, 1973). Results are expressed as percentage (w/w basis) of carbon in the air-dry soil.

2. NSI data for ALC reclassification

The following parameters have been supplied from the NSI databases see Table 2.1.

TABLE 2.1 Record layout of selected data from the National Soil Inventory

	FIELD	LENGTH	FORMAT	COMMENTS
1	O.S. grid of visited point	10	numeric	eeeeennnnn
2	Date of observation	6	numeric	DDMMYY
2a	Landuse	2	character	?? missing data AR arable BO bog CO coniferous DC deciduous HO horticultural crops LE ley grassland LH lowland heath MO montane OR orchard OT other PG permanent grass RE recreation RG rough grazing SC scrub SM salt marsh UG upland grass UH upland heath
3	Inaccessibility code of the true NSI point	3	character	space - not inaccessible URB - urban, factories, docks etc. RB - rural buildings, roads, railways, etc. TIP - mines, tips etc. BDY - field boundary, wall, hedges etc. ROK - bare rock at surface WAT - water OTH - other REF - access refused
4	Soil series	20	character	series name leading * denotes a variant
5	Depth to gley horizon	3	numeric	999 is no gleyed horizon

TABLE 2.1 Record layout (cont)

	FIELD	LENGTH	FORMAT	COMMENTS
6	Depth to slightly gleyed horizon	3	numeric	999 is no slightly gleyed horizon
7	Presence of coarse textured subsoil	1	character	Y/N
9	Soil disturbed indicator	1	character	Y/N
10	Depth to rock	3	numeric	999 is missing value i.e. below bottom of profile
11	Topsoil calcareous indicator	1	character	Y/N
12	Slope	2	character	degrees ?? missing data
13	Susceptibility to flooding indicator	1	character	Y/N
14	Clay content	6	numeric of form - 999.9	% -1.0 is missing value
15	Silt content	6	numeric of form - 999.9	% -1.0 is missing value
16	Texture class	3	character	IF 14, 15 or 17 are missing value then this is PSC of top horizon ELSE it is texture class of the top 25 cm determined from 14, 15 & 17
17	Carbon > 12% indicator	1	character	Y/N space is missing value
18	Depth to slowly permeable layer	4	numeric of form -999	>= 0 - depth -1 - no slowly permeable layer -999 - not known
19	Average stone abundance in top 25cm - (code)	1	character	O - < 1% F - 1-5% C - 6-15% M - 16-35% A - 36-70% X - 71-100%
20	Average stone size in top 25cm - (code)	2	character	space - <0.2cm VS - 0.2-0.6cm S - 0.7-2.0cm M - 2.1-6.0cm L - 6.1-20.0cm VL - 20.1-60.0cm B - >60cm

TABLE 2.1 Record layout (cont)

	FIELD	LENGTH	FORMAT	COMMENTS
21	Erosion risk	1	character	Y/N M is missing value
22	Zn	6	numeric of form - 99999	% -1 is missing data
23	Cu	7	numeric of form - 9999.9	% -1.0 is missing data
24	Ni .	6	numeric of form - 999.9	% -1.0 is missing data
25	Cd	6	numeric of form - 999.9	% -1.0 is missing data
26	Pb	6	numeric of form - 99999	% -1 is missing data
27	AP wheat	4	numeric	mm -1 is missing data
28	AP potatoes	4	numeric	mm -1 is missing data
29	Bottom depth in AP calculations	3	numeric	Depth to non-rooting horizon if it exists ELSE lowest depth recorded for profile

2.1 Soil subgroups

The soil subgroup is the middle category of soil classification and has been used to stratify some of the data extracted. The full classification of the soils of England and Wales is described by Avery (1980). A brief description of the soil subgroups is given in Table 2.2 below.

TABLE 2.2

Classes in Higher Categories
(Asterisks indicate subgroups not listed in Avery 1973)

<i>Major soil group</i>	<i>Soil group</i>	<i>Soil subgroup</i>
1. Terrestrial raw soils	1.1 Raw sands	
	1.2 Raw alluvial soils	
	1.3 Raw skeletal soils	
	1.4 Raw earths	
	1.5 Man-made raw soils	
2. Raw gley soils	2.1 Raw sandy gley soils	
	2.2 Unripened gley soils	
3. Lithomorphic soils	3.1 Rankers	3.11 Humic rankers
		3.12 Gleyic rankers*
		3.13 Brown rankers
		3.14 Podzolic rankers
		3.15 Stagnogleyic rankers
	3.2 Sand-rankers	3.21 Typical sand-rankers
		3.22 Podzolic sand-rankers
		3.23 Gleyic sand-rankers
	3.3 Ranker-like alluvial soils	3.31 Typical ranker-like alluvial soils
		3.32 Gleyic ranker-like alluvial soils
	3.4 Rendzinas	3.41 Humic rendzinas
		3.42 Grey rendzinas
		3.43 Brown rendzinas
		3.44 Colluvial rendzinas
		3.45 Gleyic rendzinas
		3.46 Humic gleyic rendzinas
		3.47 Stagnogleyic rendzinas*
	3.5 Pararendzinas	3.51 Typical pararendzinas
3.52 Humic pararendzinas		
3.53 Colluvial pararendzinas		
3.54 Stagnogleyic pararendzinas		
3.55 Gleyic pararendzinas		
3.6 Sand-pararendzinas	3.61 Typical sand pararendzinas	
	3.62 Gleyic sand pararendzinas*	

Major soil group	Soil group	Soil subgroup
	3.7 Rendzina-like alluvial	3.71 Typical rendzina-like soils alluvial soils 3.72 Gleyic rendzina-like alluvial soils 3.73 Humic gleyic rendzina-like alluvial soils*
4. Pelosols	4.1 Calcareous pelosols 4.2 Non-calcareous pelosols 4.3 Argillic pelosols	4.11 Typical calcareous pelosols 4.21 Typical non-calcareous pelosols 4.31 Typical argillic pelosols
5. Brown soils	5.1 Brown calcareous earths	5.11 Typical brown calcareous earths 5.12 Gleyic brown calcareous earths 5.13 Stagnogleyic brown calcareous earths 5.14 Colluvial brown calcareous earths;
	5.2 Brown calcareous sands	5.21 Typical brown calcareous sands 5.22 Gleyic brown calcareous sands
	5.3 Brown calcareous alluvial	5.31 Typical brown calcareous soils alluvial soils 5.32 Gleyic brown calcareous alluvial soils 5.33 Pelogleyic brown calcareous alluvial soils*
	5.4 Brown earths	5.41 Typical brown earths 5.42 Stagnogleyic brown earths 5.43 Gleyic brown earths 5.44 Ferritic brown earths 5.45 Stagnogleyic ferritic brown earths 5.46 Gleyic ferritic brown earths* 5.47 Colluvial brown earths*
	5.5 Brown sands	5.51 Typical brown sands 5.52 Gleyic brown sands 5.53 Stagnogleyic brown sands 5.54 Argillic brown sands 5.55 Gleyic argillic brown sands

Major soil group	Soil group	Soil subgroup
	5.6 Brown alluvial soils	5.61 Typical brown alluvial soils 5.62 Gleyic brown alluvial soils 5.63 Pelogleyic brown alluvial soils*
	5.7 Argillic brown earths	5.71 Typical argillic brown earths 5.72 Stagnogleyic argillic brown earths 5.73 Gleyic argillic brown earths
	5.8 Paleo-argillic brown earths	5.81 Typical paleo-argillic brown earths 5.82 Stagnogleyic paleo-argillic brown earths 5.83 Gleyic paleo-argillic brown earths*
6. Podzolic soils	6.1 Brown podzolic soils	6.11 Typical brown podzolic soils 6.12 Humic brown podzolic soils. 6.13 Paleo-argillic brown podzolic soils 6.14 Stagnogleyic brown podzolic soils 6.15 Gleyic brown podzolic soils
	6.2 Humic cryptopodzols	6.21 Typical humic cryptopodzols 6.22 Ferri-humic cryptopodzols*
	6.3 Podzols	6.31 Humo-ferric podzols 6.32 Humus podzols 6.33 Ferric podzols 6.34 Paleo-argillic podzols
	6.4 Gley-podzols	6.41 Typical gley-podzols 6.42 Humo-ferric gley-podzols 6.43 Stagnogley-podzols
	6.5 Stagnopodzols	6.51 Ironpan stagnopodzols 6.52 Humus-ironpan stagnopodzols 6.53 Hardpan stagnopodzols 6.54 Ferric stagnopodzols

Major soil group	Soil group	Soil subgroup
7. Surface-water gley soils	7.1 Stagnogley soils	7.11 Typical stagnogley soils
		7.12 Pelo-stagnogley soils
		7.13 Cambic stagnogley soils
		7.14 Paleo-argillic stagnogley soils
		7.15 Sandy stagnogley soils
	7.2 Stagnohumic gley soils	7.21 Cambic stagnohumic gley soils
		7.22 Argillic stagnohumic gley soils
		7.23 Paleo-argillic stagnohumic gley soils
		7.24 Sandy stagnohumic gley soils
8. Ground-water gley soils	8.1 Alluvial gley soils	8.11 Typical alluvial gley soils
		8.12 Calcareous alluvial gley soils
		8.13 Pelo-alluvial gley soils
		8.14 Pelo-calcareous alluvial gley soils
		8.15 Sulphuric alluvial gley soils
	8.2 Sandy gley soils	8.21 Typical sandy gley soils
		8.22 Calcareous sandy gley soils
	8.3 Cambic gley soils	8.31 Typical cambic gley soils
		8.32 Calcareous cambic gley soils
		8.33 Pelo-cambic gley soils
	8.4 Argillic gley soils	8.41 Typical argillic gley soils
		8.42 Sandy argillic gley soils
	8.5 Humic-alluvial gley soils	8.51 Typical humic-alluvial gley soils
		8.52 Calcareous humic-alluvial gley soils
		8.53 Sulphuric humic-alluvial gley soils
	8.6 Humic-sandy gley soils	8.61 Typical humic-sandy gley soils
		8.62 Calcareous humic-sandy gley soils*
	8.7 Humic gley soils	8.71 Typical humic gley soils
		8.72 Calcareous humic gley soils
		8.73 Argillic humic gley soils

<i>Major soil group</i>	<i>Soil group</i>	<i>Soil subgroup</i>
9. Man-made soils	9.1 Man-made humus soils	9.11 Sandy man-made humus soils 9.12 Earthy man-made humus soils
	9.2 Disturbed soils	
10. Peat soils	10.1 Raw peat soils	10.11 Raw oligo-fibrous peat soils 10.12 Raw eu-fibrous peat soils 10.13 Raw oligo-amorphous peat soils 10.14 Raw eutro-amorphous peat soils
	10.2 Earthy peat soils	10.21 Earthy oligo-fibrous peat soils 10.22 Earthy eu-fibrous peat soils 10.23 Earthy oligo-amorphous peat soils 10.24 Earthy eutro-amorphous peat soils 10.25 Earthy sulphuric peat soils

2.2 NSI parameters required for ALC

The parameters required for classifying the land according to the revised ALC scheme of the Ministry of Agriculture, Fisheries and Food are described in detail in MAFF (1988). The sections which follow describe the relevant parameters stored directly in the NSI database and the computation of the others needed, for example crop available water, from the stored data.

2.2.1 Depth to a gleyed or slightly gleyed horizon

The depth to a gleyed or slightly gleyed horizon is a fundamental property of the soil which can be determined from the soil classification. Soil subgroups are defined partly on this basis. The following sections define the relationship between soil subgroup and depth to a gleyed or slightly gleyed horizon.

- a. *The following soil subgroups (see Section 2.1) have no gleyed horizon starting within 80cm depth and no slightly gleyed horizon starting within 60cm depth :-*

Subgroups	1.1 1.2 1.3 1.4 1.5
Subgroups	3.13 3.14 3.21 3.22 3.31 3.41 3.42 3.43 3.44 3.51 3.52 3.53 3.61 3.71
Subgroups	5.11 5.14 5.21 5.31 5.41 5.44 5.47 5.51 5.54 5.61 5.71 5.81
Subgroups	6.11 6.12 6.13 6.21 6.22 6.31 6.32 6.33 6.34

- b. *The following subgroups have **no gleyed horizon starting within 40cm depth** :-*

Subgroups	3.15 3.23 3.32 3.45 3.46 3.47 3.54 3.55 3.62 3.72 3.73
Subgroups	4.21 4.31
Subgroups	5.12 5.22 5.32 5.33 5.42 5.43 5.45 5.46 5.52 5.53 5.55 5.62 5.63 5.72 5.73 5.82 5.83
Subgroups	6.14 6.16

- c. All other subgroups have no depth limits for gleying or slightly gleying.

2.2.2 Depth to a gleyed horizon

This is determined from the upper depth of the first horizon, that is a *gleyed* horizon, with its upper depth \geq the gleying limit. i.e. horizon nomenclature contains 'g'.

Exceptions are all A horizons in the above lists of subgroups (Section 2.2.1 a, b - i.e. for NSI data in the subgroups listed above all Ag nomenclatures have been treated as A(g). This because some NSI data in the above subgroups were miscoded Ag instead of A(g).

2.2.3 Depth to slightly gleyed horizon

This is determined from the upper **depth of the first horizon**

WITH an upper depth \geq the slightly gleying limit

AND the horizon not a 'A' horizon

AND the horizon not a 'g' horizon

AND the presence of main or subsidiary mottles

WITH

CHROMA \geq 5

OR VALUE \geq 4

BUT excluding 1) VALUE = 4 or 5 **AND** CHROMA = 4

2) VALUE = 4 **AND** CHROMA = 3

2.2.4 Marine alluvial soils

All series (including variants) in marine alluvium are defined as Eb - see Clayden and Hollis (1984, p60).

If no series is recorded, then the soil is regarded as developed in marine alluvium if the soil subgroup contains the word 'alluvial'; these subgroups are:-

1.2
3.31 3.32 3.71 3.72 3.73
5.31 5.32 5.33 5.61 5.62 5.63
8.11 8.12 8.13 8.14 8.15 8.51 8.52 8.53

2.2.5 Soils susceptible to flooding

All series (including variants) defined as Ea are susceptible to flooding - see Clayden and Hollis (1984, p58).

If no series is recorded, then the soil is susceptible to flooding if the soil subgroup contains the word 'alluvial'. These subgroups are:-

1.2
3.31 3.32 3.71 3.72 3.73
5.31 5.32 5.33 5.61 5.62 5.63
8.11 8.12 8.13 8.14 8.15 8.51 8.52 8.53

If this condition has been satisfied, the soil is susceptible to flooding

2.2.6 Coarse textured subsoil

There is a coarse textured subsoil if there is an horizon:

WITH the upper depth \geq topsoil depth

AND the lower depth \leq depth to rock

AND [(upper depth $<$ 80 **AND** lower depth $>$ 80) **OR** upper depth = 80]

AND PSC = S, LS, SL, SZL, ZL

2.2.7 Calcareous topsoil

The topsoil is calcareous if the first O, H or A horizon is slightly calcareous, calcareous or very calcareous (Hodgson 1976, p57). If the first horizon is a non-calcareous H horizon then the topsoil is calcareous if the first underlying A horizon is slightly calcareous, calcareous or very calcareous.

2.2.8 Depth to slowly permeable horizon

An horizon is considered to be slowly permeable if the saturated hydraulic conductivity is less than 0.1m/d, equivalent to an air capacity (volume of pores greater than 60 μ m) of less than 5 per cent. Horizons with these properties are effectively impermeable to the downward percolation of water. If no saturated hydraulic conductivity measurements are available, slowly permeable horizons can be inferred from packing density (Hall et al 1977). The computer based rules for determining the presence of a slowly permeable horizon are given below.

TO DETERMINE PRESENCE OF A SLOWLY PERMEABLE HORIZON

A. MARINE ALLUVIUM SOILS

These are defined as having parent material Eb (Clayden and Hollis 1984, p60), are not slowly permeable even if such soils are clayey because the soil particles do not pack densely enough in the marine environment to produce low air capacities (<5%).

B. INDETERMINATE

These are alluvial soils with series name specified but belonging to one of the following subgroups:-

1.2 3.31 3.32 3.71 3.72 3.73 5.31 5.32 5.33 5.61 5.62 5.63 8.11 8.12 8.13 8.14
8.15 8.51 8.52 8.53

C. NON MARINE ALLUVIAL SOILS

The depth to slowly permeable horizon is the upper depth of first horizon satisfying one of the conditions in Table 2.3 below, otherwise there is no slowly permeable horizon.

TABLE 2.3 Conditions for a slowly permeable horizon

SOIL OR HORIZON TYPE [disturbed soils (9.2)] or [matrix hue = aR or bYR (where a is any value b <= 5)] or [horizon 'g' or '(g)']	CLAY > 18% [PSC is SCL or CL or ZCL or SC or ZC or C or ARL ie MARL]	STRUCTURE SHAPE PED_SHAPE	STRUCTURE GRADE PED_GRADE	STRUCTURE SIZE PED_SIZE	CONSISTENCE [porosity is slight (SP) or very slight (VSP)]	SLOWLY PERMEABLE HORIZON
-	-	GRANULAR (GRN)	-	-	-	N
Y	Y	BLOCKY (SAB)	weak (WK) or very. weak (VWK)	coarse (C)	-	Y
Y	Y	BLOCKY (SAB)	weak (WK) or very. weak (VWK)	very coarse (VC)	-	Y
Y	Y	ANGULAR BLOCKY (BKY)	weak (WK) or very. weak (VWK)	fine (F)	-	Y
Y	Y	ANGULAR BLOCKY (BKY)	weak (WK) or very. weak (VWK)	medium (M)	-	Y
Y	Y	ANGULAR BLOCKY (BKY)	moderate (MOD)	medium (M)	VSP only	Y
Y	Y	ANGULAR BLOCKY (BKY)	-	coarse (C)	-	Y
Y	Y	ANGULAR BLOCKY (BKY)	-	very coarse (VC)	-	Y
Y	Y	PRISMATIC (PR)	weak (WK) or very. weak (VWK)	fine (F)	-	Y
Y	Y	PRISMATIC (PR)	-	medium (M)	-	Y
Y	Y	PRISMATIC (PR)	-	coarse (C)	-	Y

Y	Y	PRISMATIC (PR)	-	very coarse (VC)	-	Y
Y	Y	PLATY (PTY)	-	-	-	Y
Y	Y		MASSIVE (MAS)	-	-	Y
Y	N		MASSIVE (MAS)	-	Y	Y
ALL OTHER CONDITIONS						N

2.2.9 Erosion risk

Erosion risk depends on the texture of the surface soil, its structural stability, slope and land cover (Table 2.4). The risk assessment undertaken here does not take account of land cover.

TABLE 2.4 To determine if there is an erosion risk

RELATIVELY STABLE SOILS [PSC of first horizon is SCL or CL or SC or ZC or C]	SLOPE	EROSION RISK
	??	M
Y	=>7°	Y
N	=>3°	Y
ALL OTHER CONDITIONS		N

2.2.10 Particle size class

Particle size class was recorded on the NSI forms using the classes as defined in Hodgson (1976) and the abbreviations listed in Table 2.5. Clay and silt percentages (as estimates) were also recorded on the forms and particle size analyses were done on topsoil samples.

To determine peaty particle size classes, the organic carbon contents needs to be taken into account. This is shown in Table 2.5.

TABLE 2.5 To determine PSC

CARBON	SILT / CLAY	TEXTURE
missing	-	???
<= 12%	either missing	???
> 12%	either missing	Pty
<= 12%	both present	triangular diagram
>12% & <= 21%	silt + clay >= 50%	PL
"	silt + clay < 50%	PS
>12% & <= 30%	silt + clay >= 50%	LP
"	silt + clay >= 50	PS
> 30%	-	P

Abbreviations:

P	Peat
Pty	Peaty
PS	Peaty sand
LP	Loamy Peat
PL	Peaty loam

2.2.11 Stoniness in the topsoil

Stoniness in the top 25cm is required for ALC and MAFF (1988) specifies the abundance and size of stones which affect classification. Table 2.6 lists the abundance and size limits for the NSI database. The thickness of the surface horizon for an NSI profile is often less than 25cm and so the stoniness of the horizons spanning 0-25cm has to be determined.

TABLE 2.6 To determine stoniness in the top 25 cm

STONE ABUNDANCE			STONE SIZE		
STONE ABUNDANCE CODE	RANGE %	AVERAGE VALUE %	STONE SIZE CODE	RANGE cm	AVERAGE VALUE cm
O	< 1	0	VS	0.2 - 0.6	0.4
F	1 - 5	2.5	S	0.7 - 2.0	1.3
C	6 - 15	10	M	2.1 - 6.0	4
M	16 - 35	25	L	6.1 - 20	13
A	36 - 70	53.5	VL	20.1 - 60	40
X	70 - 100	85	B	> 60	80

Algorithm for determining the abundance of stones in the top 25cm.

STONE ABUNDANCE IN TOP 25 CM =

$$\frac{1}{25} \times \sum [\text{stone abundance average value} \times (X - Y)] \quad (\text{over all horizons with upper depth} < 25 \text{ cm})$$

where X is lower depth if $\leq 25\text{cm}$ else 25 cm
Y is upper depth of horizon

Algorithm for determining the size of stones in the top 25cm.

STONE SIZE OF TOP 25 CM =

Stone size occupying the largest volume, where volume is:

$$S_{\text{by stone size}} \quad [\text{stone abundance average value} \times (X - Y)] \quad (\text{over all horizons with upper depth} < 25 \text{ cm})$$

where X is lower depth if $\leq 25\text{cm}$ else 25 cm
Y is upper depth of horizon

N.B. where there is equal volume the largest size stone is to be taken.

The calculated stone abundance is converted to codes using Table 2.7.

TABLE 2.7 Stone abundance

CALCULATED STONE ABUNDANCE %	CODE %
< 1	< 1
=>1 and <=5	1 - 5
> 5 and <=15	6 - 15
> 15 and <=35	16 - 35
> 35 and <=70	36 - 70
> 70	70 - 100

2.2.12 Determination of available water for wheat and potatoes

The methodology for calculating the crop-adjusted soil available water capacity (AP) for the major arable crops in UK was developed by NSRI (Hall et al 1977, Thomasson 1979, Jones and Thomasson 1993). Operationally, the procedures have been implemented in LandIS through the APTAB module. The procedure adopted here is also described in Appendix 4, MAFF (1988, p41-50). An estimate of the structural quality - good, moderate or poor - of the soil is required together with texture and organic matter content. The latter is taken into account through Table 2.5 [peat, peaty loam etc.]. The determination of structure is different from MAFF (1988) and is therefore described in detail below.

2.2.12.1 Determination of soil structure

Table 2.8 defines the rules for the determination of soil structure from particle size class (PSC), ped grade, ped shape and ped size. This is complex but comprehensive. The particle size class (PSC) and ped grade, shape and size are described by Hodgson (1976, p 30-38).

Ped size:	XF	eXtra Fine	Ped Grade:	WK	Weak
		VF	Very Fine	VWK	Very Weak
		F	Fine	WKA	Weak-apedal
		M	Medium	STR	Strong
		C	Coarse	VST	Very Strong
		VC	Very Coarse		

Soil structure is classified as:

p	poor	m(g)	moderate to good
m	moderate	g	good

Table 2.8 Rules for soil structure based on PSC, Ped Grade, Ped Shape, Ped Size

TEXTURAL GROUPS		S LS				SL SZL ZL				SCL CL ZCL SC ZC C			
PED_GRADE		Weak WK, VWK, WKA	Mod MOD	Strong STR, VST	Miss	Weak WK, VWK, WKA	Mod MOD	Strong STR, VST	Miss	Weak WK, VWK, WKA	Mod MOD	Strong STR, VST	Miss
PED_SHAPE	PED_SIZE												
*Apedal single grain SG	-	m(g)	m(g)	m(g)	m(g)	m(g)	m(g)	m(g)	m(g)	m(g)	m(g)	m(g)	m(g)
*Apedal massive MAS	-	m	m	m	m	p?	p?	p?	p?	p	p	p	p
Granular GRN		g	g	g	g	g	g	g	g	g	g	g	g
	XF,VF,F	g	g	g	g	g	g	g	g	g	g	g	g
	M	g	g	g	g	g	g	g	g	g	g	g	g
	C	g	g	g	g	g	g	g	g	g	g	g	g
	VC	g	g	g	g	g	g	g	g	g	g	g	g
Sub-angular Blocky SAB		m	m	g	?	m	?	?	?	m	m	?	?
	XF,VF,F	m	m	g	?	m	g	g	?	m	g	g	?
	M	m	m	g	?	m	g	g	?	m	g	g	?
	C	m	m	g	?	m	m	g	?	m	m	m	m
	VC	m	m	g	?	m	m	m	m	m	m	m	m
Angular		m	g	g	?	m	?	?	?	?	?	?	?

Blocky BKY	XF,VF,F	m	g	g	?	m	m(g)	m(g)	?	m	m	m	?
	M	m	g	g	?	m	m	m	m	m*	m*	m*	m*
	C	m	g	g	?	m	m	p	?	p	m*	m*	?
	VC	m	g	g	?	m	p	p	?	p	p	p	p
Prismatic PR or COL		m	?	?	?	m	?	?	?	?	?	?	?
	XF,VF,F	m	m	m	m	m	m	m	m	m*	m*	m*	m*
	M	m	m	p	?	m	m	m	m	p	m*	m*	?
	C	m	p	p	?	m	p	p	?	p	p	p	p
Platy PTY	VC	m	p	p	?	m	p	p	?	p	p	p	p
		m	m	?	?	?	?	?	?	p	p	p	p
	XF,VF,F	m	m	m	m	m	m	m	m	p	p	p	p
	M	m	m	m	m	p	m	m	?	p	p	p	p
	C	m	m	m	m	p	p	p	?	p	p	p	p

Note 1 * these are coded as PED_GRADE not PED_SHAPE on NSI documents

Note 2 m*

IF ped faces are "pale" or "grey" (see MAFF (1988, p33))

WITH chroma at least 1 unit less than matrix chroma

THEN take as p (poor)

ELSE m (moderate)

WITH "grey" is value 4 to 8 **AND** chroma 0 to 2

AND "pale" is (value 6 to 8 **AND** chroma 3 to 4)

OR (value 5 **AND** chroma 3)

Note 3 p? take as p and m(g) take as m

2.2.12.2 Soil texture classes

The following (Table 2.9) is a list of soil texture classes in the NSI data and the equivalent textures used in Table 14 of MAFF (1988, p46).

TABLE 2.9 NSI soil textures with APTAB equivalents

NSRI PSC	APTAB TEXTURE CODE		NSRI PSC	APTAB TEXTURE CODE		NSRI PSC	APTAB TEXTURE CODE
MINERAL			HUMOSE			ORGANIC	
C	C		hC	OC		LP	LP
CL	CL		hCL	OL		P	Hum
GVL	GVL		hGVL	GVL		SP	SP
LS	MLS		hLS	OS		FibLP	Fib
S	MS		h S	OS		FibP	Fib
SC	SC		h SC	OC		FibSP	Fib
SCL	SCL		h SCL	OL		HumLP	LP
SKL	SKL		h SKL	SKL		HumP	Hum
SL	MSL		h SL	OL		HumSP	SP
SZL	MSZL		h SZL	OL		SedLP	LP
ZC	ZC		h ZC	OC		SedP	LP
ZCL	ZCL		h ZCL	OL		SfbLP	Fib
ZL	ZL		h ZL	OL		SfbP	Fib
CLS	CLS		hCLS	OS		SfbSP	Fib
CS	CS		hCS	OS			
CSC	SC		hCSC	OC			
CSCL	SCL		hCSCL	OL			
CSL	CSL		hCSL	OL			
CSZL	CSZL		hCSZL	OL			
FCL	CL		hFCL	OL			
FLS	FLS		hFLS	OS			
FS	FS		hFS	OS			
FSC	SC		hFSC	OC			
FSCL	SCL		hFSCL	OL			
FSL	FSL		hFSL	OL			
FSZL	FSZL		hFSZL	OL			
FZL	ZL		hFZL	OL			
MARL	MARL		hMARL	MARL			
MLS	MLS		hMLS	OS			
MS	MS		hMS	OS			
MSCL	SCL		hMSCL	OL			
MSL	MSL		hMSL	OL			
MSZL	MSZL		hMSZL	OL			
***	MARN						

NB **MARL** is special entry added to MAFF (1988, Table 14) for subsoil only 25 (20)

*** **These are marine alluvium soils with PSC FSZL, FLS, FSL (Clayden and Hollis 1984)**

Where marine alluvium soils are:-

all series (including variants) defined as Eb see Clayden and Hollis (1984, p60) or
if no series recorded then subgroup (containing word 'alluvial')

1.2	3.31 3.32 3.71 3.72 3.73
5.31 5.32 5.33 5.61 5.62 5.63	8.11 8.12 8.13 8.14 8.15 8.51 8.52 8.53

2.2.12.3 Rock and Stone classification

Table 2.10 correlates the rock and stone classification codes used by NSRI, and implemented in LandIS, with the categories in MAFF (1988, p47).

TABLE 2.10 Rock and stone classification

Rock/stone types MAFF (1988, Table 15)	Code	LandIS stone codes
All hard rocks or stones (i.e. those which cannot be scratched with a finger nail)	A	1** or 3** with series not in list ¹ , 201, 202, 203, 204 (not subtype 3), 205, 209, 211, 213, 214, 215 (not subtypes 8 & 9) 219, 998 (artefact), 999 (hard)
Soft, medium or coarse grained sandstone	B	210
Soft 'weathered' igneous or metamorphic rocks or stones	C	1** or 3** with series in list ¹
Soft oolitic or dolomitic limestones	D	215 (subtypes 8 & 9), 216, 217, 218
Soft fine grained sandstones	E	207
Soft, argillaceous or silty rocks or stones	F	204 (subtype 3), 206, 208, 221
Chalk or chalk stones	G	220
Gravel ¹ with non-porous (hard) stones	H	
Gravel ¹ with porous stones (mainly soft types listed above)	I	

1. Gravel with at least 70% rounded stones by volume
2. List¹ (all series including variants) defined as Fa Fb Fc Fd Fe Ff - see Clayden and Hollis (1984, p67-68).

2.2.12.4 Layer type definitions

The APTAB routines require soil layers to be classified accordingly:-

- T topsoil
- O organic subsoil
- S non-organic subsoil
- X non-rooting

The code is used with soil structure to determine the column and with texture to determine the row of in MAFF (1988, Table 14).

The logic of determining the layer code is as follows:

CHOICE

- | | |
|---------------------------------------|---------------------|
| horizon notation = CG | then layer code = X |
| horizon notation = R | then layer code = X |
| horizon notation = Bf | then layer code = X |
| horizon notation contains h | then layer code = O |
| horizon notation contains A | then layer code = T |
| horizon notation contains O | then layer code = O |
| horizon notation contains L | then layer code = O |
| horizon notation contains F | then layer code = O |
| horizon notation contains H | then layer code = O |
| horizon notation contains B or E or C | then layer code = S |

else ?

END CHOICE

2.2.12.5 Validation of calculated AP values

The values of AP wheat and AP potatoes calculated for the NSI points (using the methodology described above) were compared with the equivalent AP values for individual soil series in the National Catalogue of Soils (NATCAT), within LandIS. The comparison was made for 4000 NSI sites rather than the total of 5672, because some had no soil or no soil series name had been recorded. For the most part, comparisons were good, in most cases differences were <12%. However, for shallow soils over porous rock, particularly chalk, APTAB greatly underestimates AP when compared with NATCAT. For closer agreement with NATCAT values, AP for these shallow soils should be inflated by approximately 50mm.

3. References

- AVERY, B.W. (1973).** Soil classification in the Soil Survey of England and Wales. *Journal of Soil Science* **24**, 324-38.
- AVERY, B.W. (1980).** Soil classification for England and Wales [Higher Categories]. Survey Technical Monograph No. 14, pp67. Harpenden, UK.
- AVERY, B.W. and BASCOMB, C.L. (1982).** *Soil Survey Laboratory Methods*. Soil Survey Technical Monograph No. 6, pp83. Harpenden, UK.
- BERROW, M.L. and STEIN, W.M. (1983).** Extraction of metals from soils and sewage sludges by refluxing with *aqua regia*. *Analyst* **108**, 277-285.
- CLAYDEN, B. and HOLLIS, J.M. (1984)** *Criteria for differentiating soil series*. Soil Survey Technical Monograph No. 17, pp159. Harpenden, UK.
- COLINET, E., GONSKA, H., GRIEPINK, P. and MUNTAU, H. (1983).** *The certification of the contents of cadmium, copper, mercury, lead and zinc in a calcareous loam soil*. BCR No.141. Eur 8833, Commission of the European Communities, Brussels.
- HALL, D.G.M., REEVE, M.J., THOMASSON A.J. and WRIGHT, V.F. (1977).** *Water retention, porosity, and density of field soils*. Soil Survey Technical Monograph No.9, pp77. Harpenden, U.K.
- HODGSON, J.M. (1976).** *Soil Survey Field Handbook*. Soil Survey Technical Monograph No. 5, pp99. Harpenden, UK.
- JONES, R.J.A. and THOMASSON, A.J. (1993).** Effects of soil moisture interactions on the sustainability of land use: a European perspective. In: *Utilization of Soil Survey Information for Sustainable Land Use*. J.M. Kimble (ed). Proceedings of the Eighth International Soil Management Workshop, May 1993, 39-52. USDA, Soil Conservation Service, National Soil Survey Center.
- KALEMBASA, S.J. and JENKINSON, D.S. (1973).** A comparative study of titrimetric and gravimetric methods for determination of organic carbon in soils. *Journal of the Science of Food and Agriculture* **24**, 1085-1090.
- MAFF (1988).** *Agricultural Land Classification of England and Wales*. Ministry of Agriculture, Fisheries and Food, pp52.
- McGRATH, S.P. and CUNLIFFE, C.H. (1985).** A simplified method for the extraction of the metals Fe, Zn, Cu, Ni, Cd, Pb, Cr, Co and Mn from soils and sewage sludges. *Journal of the Science of Food and Agriculture* **36**, 794-798.
- McGRATH, S.P. and P.J. LOVELAND (1992).** *The Soil Geochemical Atlas of England and Wales*. pp101. Blackie Academic & Professional.
- THOMASSON A.J. (1979).** Assessment of soil droughtiness. In: M.G. Jarvis and D. Mackney(ed.). *Soil Survey Applications*. Soil Survey Technical Monograph No. 13, 43-50. Harpenden, U.K.

WATERS, D.F and SWEETMAN, I.C. (1955). The Rukuhia soil grinder. *Soil Science* **79**, 411-413.