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NORTH SCARLE RESTORATION STUDY (ST 06/006)

REPORT ON SOILS AND AGRICULTURAL LAND CLASSIFICATION

1.0 INTRODUCTION

1.1 The Resource Planning Group were requested to carry out an agricultural land classification survey of the recently restored sand and gravel pits, at the North Scarle Restoration study site. This survey, conducted in October 1989, was to form an input into an ongoing experiment to assess the effectiveness of restoration by infilling with pulverised fuel ash (PFA), and to assess the effectiveness of aftercare treatments in achieving a high standard of agricultural restoration.

2.0 BACKGROUND TO THE SITE

2.1 Pre Working Survey

A Pre working survey of the study site was undertaken Mr R W Swann, MAFF, during the late 1970's. This identified 2 main soil types/complexes which were texturally similar, but showed slight differences in drainage status, dependent on their relative position in the landscape and proximity to fluctuating groundwater levels. Generally speaking soils on site were reported to comprise sand, or loamy sand textures to one metre depth. Topsoil organic matter levels were in the order of 3%, and drainage was reported to be imperfect to moderate. No description of subsoil structural aggregates was made, although it was stated that bands of iron enrichment did occur below 50 cm in isolated areas. An earlier survey undertaken by Mr S D Robson (SSLRC) indicates topsoil depths across the site were in the order of 25-30 cm depth, and that groundwater was present at 120 cm in a profile pit dug in mid September 1975, despite an exceptionally dry summer.

2.2 It is likely that land of this type would be graded no higher than subgrade 3b under both the earlier, and revised agricultural land classification systems, due to susceptibility to drought. Where iron enriched pans occur which are acidic, and form a barrier to plant roots, the risk of drought is exacerbated, and land is more appropriately graded 4. No indication is given in the pre working survey report of whether the pans identified are sufficiently severe and/or near the surface to represent this degree of constraint.

2.3 Climatological Data

Site specific dimate data was extracted from the 5 km grid agroclimatic dataset compiled by the Meteorological Office (Met Office, 1989). This shows the average annual rainfall to be 565 mm, which is low by national standards. Field capacity days, at 109 per annum, are also low, and soil moisture deficits of 115 mm and 109 mm are reported for wheat and potatoes respectively.

2.4 Geology

The pre working geology of this site has been described in detail in an earlier report, and is reported to comprise Beeston river terrace gravel deposits overlying Keuper Marl.

2.5 Working History

At the time of inspection the study site was divided into 4 cells (See map 1). Those bordering the road, and referred to as 2a and 2b are reported to have been filled in 1987, and soiled during 1987 and 1988. Cell 3, to the rear of the farm buildings, is reported to have been filled during 1988 and soiled during 1989. At the time of inspection however restoration within cell 3 appeared to be incomplete, since soil cover was absent in significant areas. Cell 5 was undergoing filling with PFA slurry.

3.0 AGRICULTURAL LAND CLASSIFICATION: 1989 SURVEY

Background

3.1 This survey was carried out on the 11th October 1989. Data connection was restricted chiefly to cell numbers 2a and 2b since only these two areas appeared to be fully restored. A total of 11 soil inspections were made in these areas at approximately 50 metre intervals using a hand held 110 cm soil auger, and supplementary information collected from 2 soil profile pits, (see maps 2 and 3) Soil samples were taken on site for laboratory determinations of particle size distributions, and for assessing the possible toxicity effects arising from the presence of PFA fill material close to the surface. At the time of survey the land was under a mixed grass clover sward and was being grazed by sheep. The site was assessed as level or gently undulating and did not appear to have a discernible overall gradient in any one direction.

3.2 Four supplementary soil inspections were made in the inadequately/partially restored land in cell 3, located at the rear of the farm buildings. This land was under a thin cover of grass but had also been colonised by weeds, and had patches of bare ground where soil cover was absent.

3.3 Soil Description (Cells 2a and 2b)

Similar soil textures were identified to those found in the preworking survey. (In common with the preworking survey, topsoils, hand textured as loamy sand were laboratory analysed as sand possibly due to the presence of organic matter).

3.4 Topsoil textures typically comprised of loamy sand or sand, in the depth range 23-55 cm (modal depth 30 cm,) organic matter levels were recorded in the order of 2%. Topsoil structure was observed to be weakly developed and comprise medium and fine sub angular blocky aggregates with much disaggregated material.

3.5 Subsoil textures typically comprise loamy sand or sand, occasionally sandy loam, or loamy fine sand. Subsoil depth is in the range 35-110+, although there was a noticeable increase in the proportion of shallower soils (30-55 cm deep) towards the northern end of cell 2b. Subsoil structure (where an adequate depth was present) was observed to be massive and compact with firm consistence.

PFA

3.6 All profiles except one overlay PFA at variable depth. PFA is made up of glassy spherical particles in the fine sand and silt range. At North Scarle the PFA was laboratory analysed as a sandy silt loam. Due to the uniformity of particle size in PFA, and the tendency not to form any structural aggregates the PFA does not behave like a sandy silt loam soil. For example, tests in the United States indicate that the permeability of PFA is generally low, although this will vary with composition and degree of compaction. Furthermore, although it is capable of holding significant reserves of available water, (20%), this is not always extractable by plant roots, possibly due to the reluctance of plant roots to penetrate the PFA horizon. Although capillary rise, from an existing groundwater source will occur within the PFA, at North Scarle it is unlikely that this will supplement the overlying coarse loamy and sandy soil textures, as these form too steep an hydraulic gradient.

3.7 Additionally in the lagoon system used at North Scarle, cement-like layers may form in areas due to pozzolonic activity*. These further reduce permeability, and are also likely to act as a barrier to pioneering plant roots. At North Scarle evidence of this cementation was only observed at one location where structure was observed to be laminar and have a firm to very firm consistence. Elsewhere the PFA was observed to be mainly structureless.

3.8 Soil Description (Cell 3)

Where soil was present profiles typically consisted of sand textures to 55 75 cm depth overlying PFA. No discernible colour change was evident indicating a separate topsoil/subsoil layer. The overall colour was dark brown (10 YR 3/2 or 10 YR 33) and organic matter levels at the one sample location were measured at 1.5%. Where present the grass sward was thin and poorly established. In significant areas the PFA was exposed at the surface.

* chemical reaction occuring in the presence of lime.

3.9 Rooting

Care should be taken when interpreting the degree of development of root systems in soils since this can depend heavily on the rooting characteristics of the particular crop present, and the timing/size of rainfall events occurring in the preceeding season. At North Scarle, root development appeared to be governed largely by soil structural factors, with a strong correlation being noted between soil loosening (effective to 40/45 cm depth), -and overall penetration by roots. It should be noted that the descriptions of root development provided below are based on observations from two soil profile pits located in cell 2a and 2b respectively.

3.10 At pit 1 (55 cm of soil material over PFA), roots were observed to be common to 45 cm; few to 55 cm, and rare, often dead in the surface of the underlying PFA.

3.11 At pit 2 (30 cm of soil material over PFA), roots were common in the top and upper subsoils, becoming generally few in the PFA, although "pockets" of common roots were observed to 45 cm coinciding with the passage of subsoiling tines.

3.12 This suggests that root penetration is somewhat restricted in poorly structured un-loosenable soil below 45 cm and also within the PFA. The suitability of PFA as a rooting medium clearly improves when it occurs sufficiently near the surface to be loosened by a normal subsoiling tine. It is at present unclear however how effective in the longterm such loosening exercises will be, on this inherently structureless medium, since fine sand and silt sized particles of this type are notoriously prone to collapse even in undisturbed soils. Relative crop performance in the shallow northern, and deeper southern profiles may give an indication of this factor in the longer term.

4.0 AGRICULTURAL LAND CLASSIFICATION

4.1 Land was assessed "as seen" on 11 October in accordance with the Revised Guidelines and Criteria for grading the quality of agricultural land. Land quality on cell 3 was not assessed since at the time of survey this did not appear to be fully restored. The breakdown on land quality which follows relates to cell numbers 2a and 2b.

ALC	Hectares	%
3b	4.57	67
4	2.22	33
Total	6.79	100

4.2 The principal limitation to land quality is droughtiness and the relative severity of this depends on the depth of coarse loamy or sandy soil material over PFA. Although winter wetness imperfections may also occur on site, - particularly where the water holding PFA is close to the surface, these do not constitute an overriding limitation to use. Toxicity tests measuring the levels of sodium, chlorine and extractable Boron, were also made on six soil samples and the results are presented at appendix 1. Previous Studies (Holiday, R. post 1961) do not suggest that toxicity is a limiting factor to ALC grade. Soil nutrient levels are short term factors, which are influenced by management and are therefore not normally considered in arriving at an ALC grade.

Grade 3b

4.3 This occurs in cell 2a and on the southern part of cell 2b where sandy and coarse loamy soils overlie PFA below 75-110 cm depth. In calculating moisture balances, rooting was assumed to occur throughout the coarse loamy/sandy upper horizons, but not into the underlying PFA. This is in keeping with soil profile pit observations in cell 2a. (This reluctance of plant roots to penetrate the PFA where an adequate amount of overlying soil material is present, is in keeping with observations made on other PFA restorations in the Trent Valley).

4.4 As this site was restored in a south to north direction, it is probable that the generous depths of topsoils and subsoils recorded in the southern area, may be due to poor soil "budgeting" during the restoration process.

Grade 4

4.5 This occurs to the northern end of cell 2b where sandy/coarse loamy soils overlie PFA below 30-55 cm. Since roots were observed in loosened pockets to 45 cm depth in the underlying PFA this was taken into account in moisture balance calculations. However no allowance was made for the possibility of capillary rise occurring within the PFA and replenishing the loosened, rooted surface horizons of the PFA with reserves of plant available water. This would effectively contribute to alleviating the severe droughtiness contrast present on this land. However, the occurrence of such capillary rise relies on the PFA remaining sufficiently loosened to allow continued root penetration in the long term. It is unclear at present whether the PFA is sufficiently stable structurally to allow this to occur. Land in this area is also likely to be subject to winter wetness imperfections.

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NORTH SCARLE
Soil Toxicity Analysis

APPENDIX 1

Sample No & Identification	Horizon	Org Matter (%)	Extr B (mg/l)	(Index)	Na (mg/l)	Cl (mg/l)
AB13 21956	T/S	1.5	0.5	1	4	27
AB5 21957	T/S	1.9	0.5	1	9	27
P1T1 21958	T/S	1.9	1.0	2	8	9
AB6 21960	S/S	-	4.6	4	59	9
P1T2 21961	T/S	2.2	0.5	1	6	9
P1T 2 21963	PFA	-	17.1	4	33	18