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Report F4

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Report on a Semi - Detailed Soil Survey
of the

BAKAM ROAD

Silvicultural Research Reserve,
4th DIVISION

by

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Soil Survey
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Report on a semi-detailed soil survey
of the Bakam Road Silvicultural Research Reserve, 4th Division

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Introduction

Tables

The Bakam Road Silviculture Reserve was acquired by the Forest Department in 1969. It is covered with exploited Mixed Dipterocarp Forest and most of it is not thought to have ever been clear-felled for shifting hill padi cultivation. It was acquired for silvicultural research and plantation experiments and the experiments here will be the high forest complements of those at the other sites near Sibu, which was some poor quality secondary growth prior to acquisition.

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Before drawing up a programme for the Reserve, the Silviculture Research Section requires more detailed information about the area, as this semi-detailed soil survey was undertaken in April 1970.

Introduction

The Bakam Road Silvicultural Reserve was acquired by the Forest Department in 1969. It is covered with exploited Mixed Dipterocarp Forest and most of it is not thought to have ever been clear-felled for shifting hill padi cultivation. It was **acquired** specifically for fast growing plantation experiments and the experiments here will be the high forest complements of those at the Oya Road Silvicultural Reserve, near Sibuloh, which was under poor quality secondary growth prior to acquisition.

At present there are only a small number of plots at Bakam Road, planted in the first phase of the bulk cellulose plantation trials. The soils of these plots have been surveyed in detail (Baillie, 1970) but the rest of the Reserve is only covered by a reconnaissance soil survey, in which airphoto interpretation was used extensively (Wall, 1966).

Before drawing up a programme for the Reserve, the Silvicultural Research Section require more detailed information about the area, so this semi-detailed soil survey was undertaken in April 1970.

The nearest official meteorological station is at the old Isitang Airport. For rainfall data for 27 years (up till 1965) are available. There have been rain gauges at P.S.D. roadways along the Miri - Sibuloh road. These are close to the Reserve, but the data from these installations cover only short periods and are of doubtful value.

The rainfall at the old Isitang Airport is summarised in Table 1.

Table 1
Rainfall at Isitang (1)

	4	7	8	1	2	3	4	5	6	9	10	11	Annual
Mean	11	7	6	6	3	13	2	10	12	12	13	12	101
Maximum	25	20	22	24	17	24	15	29	20	23	21	25	267
Minimum	2	1	3	0	2	1	0	2	5	9	2	6	44

Notes: (1) Figures to the nearest inch.

(2) This is the exceptionally high rainfall in the 1962-3 season, referred to in Section 1.4 below.

1. General

1.1 Cadastral

The Reserve is in the area of the original Lambir Forest Reserve, which was constituted in 1955 (S.G.G.N. No.1281 of 1.10.1955). However the Lambir Forest Reserve has been considerably reduced in area since constitution, so that, of the original 26,000 acres, only approximately 12,000 remain. This remaining area covers the higher parts of the Lambir range and is being proposed for constitution as a National Park.

The Silvicultural Reserve lies in the area that was excised by the 2nd Excision (S.G.G.N. No.L.N.46 of 2.3.1964) and was acquired in 1969 (S.G.G.N. 1306 of 13.6.69). It covers 574 acres in two blocks, separated by a road reserve, which is mostly of 3-4 chains width (see Map 1).

The Reserve lies either side of the Bakam feeder road, stretching from Mile 3 to Mile 4½ from its turn off on the main Miri-Niah road. As the Reserve is on a good road and is only 15 miles from Miri, access is good. As the road runs along its long axis, no part of the roughly quadrilateral Reserve is more than ½ mile walk from the road.

1.2 Climate

The nearest medium term meteorological station is at the old Lutong airport, for which data for 25 years (up till 1968) are available. There have been rainguages at P.W.D. roadcamps along the Miri - Niah road which are much closer to the Reserve, but the data from these installations covers such short periods as to make them of doubtful value.

The rainfall at the old Lutong airport is summarised in Table 1.

Table 1

Rainfall at Lutong (1)

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean	13	7	6	6	8	10	8	10	12	12	13	12	111
Maximum	68 ⁽²⁾	20	12	14	12	24	16	24	20	22	21	23	168
Minimum	2	1	3	0	2	1	0	2	5	9	2	6	94

- Notes: (1) Figures to the nearest inch.
 (2) This is the exceptionally high rainfall in the 1962-3 landas, referred to in Section 1.4 below.

From: Drainage and Irrigation Department Hydrological Yearbook (1968), and Seal (1958).

The mean annual rainfall is low by Sarawak standards, although the climate is still in category 1A (continuously wet) in the classification of Mohr and Van Baren (1954). The rainfall is also more evenly distributed throughout the year than in West or Central Sarawak, because the effect of the Northeast Monsoon diminishes northwards.

As a corollary of its lower rainfall, Miri receives more sunshine than elsewhere. Unfortunately the readily available sunshine data cover only one year, but they show greater insolation at Miri than at Bintulu or Kuching. They are summarised in Table 2.

Table 2
Sunshine hours in Sarawak: 1955

	Mean daily sunshine hours												Mean Annual
	J	F	M	A	M	J	J	A	S	O	N	D	
Kuching Airport	3.7	3.6	5.3	5.8	7.0	6.2	5.8	4.6	3.6	5.3	5.1	2.8	4.9
Bintulu	6.2	4.7	6.5	5.7	7.8	5.3	6.8	6.0	5.6	5.8	5.5	4.5	5.9
Miri	6.2	5.3	7.9	6.9	7.0	6.0	6.9	6.2	6.4	7.4	6.3	6.0	6.6

Figures to the nearest 0.1 hours

From: Seal (1958)

There has been a Class A evaporation pan in continuous operation at Miri since 1963, the data from which are summarised in Table 3.

Table 3
Evaporation at Miri

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean	5.3	5.7	6.4	6.7	6.7	6.6	6.6	6.7	6.3	6.1	5.7	5.6	74.2
Maximum	6.6	6.7	7.1	7.5	7.4	7.5	7.4	7.1	6.7	6.3	6.3	6.0	80.9
Minimum	4.9	4.9	5.9	6.1	5.8	6.0	6.2	6.2	5.1	5.6	4.9	4.8	71.0

Figures to the nearest 0.1 inches.

From: Drainage and Irrigation Department Hydrological Yearbooks, 1962-8.

As is to be expected from its lower rainfall and higher sunshine, evaporation is slightly higher at Miri than in West or Central Sarawak, as can be seen in Table 4.

Table 4

Mean annual evaporation in Sarawak (1963-8)

Kuching	72.6
Simanggang	67.1
Sibu	63.9
Bintulu	71.3
Miri	74.2

Figures to the nearest 0.1 inches.

From: Drainage and Irrigation Department Hydrological Yearbooks 1962-8.

It should be noted that the Reserve probably receives more rain and less sunshine than the meteorological stations at Miri. It lies in the seaward foothills of the Lambir range and therefore probably receives orographic rainfall not falling on the lowlying coastal land round Miri. The amount of this additional precipitation is not known.

1.3 Soil parent materials

The Reserve lies in an area that has been geologically investigated in considerable detail, because of the proximity of the Miri oilfield. Most of the field investigation, both in outcrops and cores, was done by geologists of Sarawak Shell Oilfields Limited. Their findings have been incorporated into the geological accounts of the Brunei area (Wilford, 1961) and of the whole state (Leichti, 1960). These accounts are essentially similar in their descriptions of the area of the Reserve.

The Reserve is underlain by sedimentary rocks of the Lower Miri and Tukai Formations. Over most of its outcrop the rocks of the Lower Miri are predominantly arenaceous, but in the Lambir area the intercalated beds of shale are locally more important. The sandstone is generally fairly soft, of light colour when fresh, and predominantly medium-fine grained. Beds of silty or shaly sandstone are also found.

The Tukai Formation is the local time - stratigraphic equivalent of the Upper Miri. It consists of a succession of massive soft sandstones and soft lignitic clays. The sandstone is medium-grained and usually yellow when fresh. A blue variant has been noted elsewhere, but was not found in the Reserve during the course of the survey. The clay-shale are often sandy and may contain nodules of harder calcareous shales.

The sediments of both Formations were laid down in shallow water in Late Tertiary times. The Miri has been given a Tgh (Pliocene) age, whilst the Tukai may be Tf (Upper Miocene) or Tgh.

Since deposition, the sediments have been subject to some folding, and the Reserve is situated on the southern limb of the Liku - Badas, syncline, so that the rocks dip northwards at angles of 10-25°.

Because of the deep weathering and the lithological similarity of the two formations, it was not possible for the writer to distinguish between them in the course of the soil survey, even in the relatively fresh exposures in the deeper cuttings along the road.

A prominent feature revealed by the road cuttings are the abundant interlayer sheets of ferricrete. These are harder than the surrounding rocks and are frequently exposed as fragments of pavement by roadside erosion. They are found more than 40 feet below the present-day ground surface. There are also concentric hollow tubes of hard ferricrete, known locally as 'pipestone', which are thought to have been formed by concentric deposition round old root channels. Fragments of pipestone are also found embedded at considerable depths and, like the ferricrete sheets, their formation is thought to date from the time of the deposition of the sediments. They are regarded as fossil features and not all related to current pedogenic processes.

The ferricrete and pipestone are harder than the surrounding rocks and are sometimes found as thin discontinuous stone layers separating the solum from the underlying weathering rock. The presence of these stone lines and the tendency to textural homogeneity from slope crest to toe noted below (see Section 3.2.1), indicate that the soils are not wholly sedentary and that considerable colluviation has occurred.

The valley bottoms have a thin and discontinuous cover of recent deposits. These are often less than 40 inches deep and overlie fairly hard rock. They show considerable size sorting but many of the coarser fragments are angular or subangular.

1.4 Topography

The Reserve lies in the northern foothills of the Lambir Hills. This range is a lithogenic feature, being built of the harder sedimentary rocks of the Lambir Formation. The rocks underlying the Reserve are of much lower competence and the area has been subject to intense erosion, so that altitudes are never more than 350 feet m.s.l. However dissection is severe, and local relief may be as much as 150 feet. The combination of deep dissection and a fairly dense drainage network means that the topography of the Reserve is surprisingly rugged, despite its low summit altitudes; and slopes are mostly in the 15-35° range. The angles of dip of the underlying rocks are low enough to permit cuesta formation, but the rocks are too uniformly soft, so that the interfluvial ridges are

homoclinal. This is in contrast to the Lambir Hills, where the harder rocks give rise to a well developed scarp and dipslope landscape.

The drainage is eastwards towards Sg. Liku (see inset to Map 1), but the pattern is not strongly controlled by the east-west strike of the underlying rocks and is of a dendritic rather than trellis type.

There are several large landslip sites in the Reserve and many smaller ones. The largest is of about 300 feet width and about the same length. Judging from the small cliff feature remaining at its upper edge, at least 8 feet of material has been removed at the centre of the area, and the secondary growth is rooted in raw weathered rock. Many of these landslips appear to be recent, and it has been suggested that similar features in the neighbouring Lambir Development Scheme area were mostly formed during the exceptionally heavy rainstorms of January 1963 (see Table 1). It is thought that the combination of intense rainfall of long duration, high soil permeability and poor cohesion in the subsoil and weathering rock initiates the slip. The failure often seems to occur at a textural boundary, where a light textured surface soil overlies a less permeable, heavier textured subsoil or an impermeable ferricrete layer (Wall, 1965). As far as can be seen, there is no tendency to slip preferentially down along the dip plane, but a more detailed study is required to confirm this.

The whole of North Sarawak was subject to exceptionally rain heavy during the 1962-3 landas season, but the density of landslip sites seems to be higher on the outcrops of the Miri and Tukau Formations than elsewhere. This is thought to be due to the poor cohesion of these rocks when weathered. This is confirmed by the low quality of road fill material that is derived from them. The embankments and cuttings along the Bakam feeder road are subject to very heavy erosion, even by Sarawak standards, because of the low cohesion of the fill available.

1.5 Vegetation

The Reserve is covered with medium - poor Mixed Dipterocarp Forest. This was lightly exploited by Yong Khaw Timber Co. for floater merantis in 1965-7. In 1969 the same licensee re-entered the area and is now exploiting it more intensively.

There are patches of secondary growth on all sites that have been recently disturbed, such as landslips, tractor paths, and the area clear felled in 1968 for the experimental afforestation plots. Resam (*Gleichinia* spp.) is an important component of this young secondary growth, but lallang (*Imperata cylindrica*) is rare or absent.

1.6 Previous Soil Survey Coverage

The Reserve is in the area mapped in the reconnaissance soil survey of the Bekenu - Niah - Suai area (Wall, 1966). As the final map scale was 1:100,000 and as fieldwork was aimed at checking aerial photograph interpretation, rather than being exhaustive in itself, much of the area was mapped as compound units, with no attempt at delineation of the component simple units. Thus the Reserve falls entirely within a delineation of the Bekenu - Nyalau compound unit, indicating a cover of medium and light textured Red Yellow Podsollic soils.

The northern part of the Lambir Development Scheme is immediately adjacent to the Reserve to the east and is covered by a semi-detailed soil survey (Wall, 1965). The hills are covered with moderately deep Red Yellow Podsollic soils ranging in subsoil texture from clay to sandy loam. The valleys are mostly covered with hydromorphic and shallow peat soils.

The experimental afforestation site in the Reserve was surveyed by the writer as part of another project in 1969 (Baillie, 1970), and the results have been incorporated into the present report.

2. Methods

2.1 Field

The detailed soil survey of the experimental afforestation site (see Map 2) was carried out by the writer and Assistant Forest Officer Abdul Manaf bin Sairi in May 1969, as part of another project (Baillie, 1970).

The ~~semi-detailed~~ survey of the rest of the Reserve took two weeks in April 1970, and was carried out by the writer and A.F.O.'s Abdul Manaf bin Sairi and James Dawos Mamit. In both the detailed and semi-detailed surveys, the soils were examined and the soil boundaries located by means of 4 feet long augers with 2 inch Edelman heads. The augerings were located relative to the experimental plots on the afforestation site, and at slope-corrected one chain intervals along rentises in the rest of the Reserve. After preliminary classification of the augering data, profile pits were located to illustrate the details of the main soil types. The descriptions and analyses from these profiles are to be found in the Appendix. The locations of the rentises and pits are shown on the maps in the end-folder.

As part of a study of the short-range variability of some Sarawak soil types, a soil variability trial was laid out in the western part of the Reserve. The layout, methods and results of this study will be reported separately at a later date.

2.2 Maps and aerial photographs

The Reserve lies within the Miri - Lambir 1:10,000 topographic survey carried out by the Land and Survey Department and published in 1968. Unfortunately this is not up to date in respect of the Bakam feeder road, so the road alignment and cadastral boundaries are taken from L. & S. Plan No.4/14-81.

The whole Reserve is covered by 1:18,000 panchromatic vertical aerial photography taken in 1967 (L. & S. Sortie No. 28/67). More recent 1:10,000 photography of the Miri - Lambir area (L. & S. Sorties 27/69 and 28/69) unfortunately only covers two small sections of northern part of the Reserve. As these fragments are, in both cases, covered only by the end photograph of a run, they cannot be examined stereoscopically.

3. Soils

3.1 General

The reconnaissance soil survey (Wall, 1966) is largely confirmed and the residual-colluvial soils of the hills are all of the Red Yellow Podsollic type, usually of medium-light texture and all of moderate depth (i.e. more than 20 inches deep to weathering rock or a very stony horizon). They have been subdivided on grounds of subsoil texture into three mapping units, which are described separately in section 3.2 below.

The narrow valley bottoms are covered with alluvial - gully wash deposits, which is often quite shallow (less than 40 inches to the underlying rock). The soils formed in these deposits can be classified according to texture and drainage, but they are distributed in such a intricate pattern that they are mapped as one complex mapping unit.

No attempt has been made to classify the cover of the recently disturbed sites such as road workings or landslips. It should be noted that the area of such land is greater than is indicated on the map, as the logging tractor paths and many of the smaller landslips are not shown.

3.2 Residual - Colluvial soils

3.2.1 General

The hills are covered with moderately deep Red Yellow Podsollic soils, the chief characteristics of which are the brown, yellow and red matrix colours and the increase in clay content with depth. There are apparent clayskins on the subsoil peds, and the increase in clay content is thought to be mainly due to vertical illuviation from the surface horizons, but there is, as yet, no convincing micromorphological evidence for this. Preferential lateral removal of the fine fractions by surface erosion may also contribute to the textural contrast down the profile.

In addition to the increase in clay content with depth, the soil colours often become redder down the profile. Thus a common colour sequence down the solum is:

	Dark yellowish brown
over	Yellowish brown
over	Yellow or brownish yellow
over	Reddish yellow
over	Multicoloured weathering rock

In some cases, especially in the medium-textured soils, the subsoil colours may even grade into yellowish red and light red, but these are usually only found in mottles and are rare as matrix colours. The above colour sequence is not invariably found and, in some soils, yellow matrix colours persist down to the weathering rock (e.g. Profile F4 E - see Appendix). Subsoil colours were noted in the field during the survey, but are not used as a criteria for further subdivision of the mapping units, as the distribution appears to be fortuitous. Also the colour differences are not thought to be of great pedological or edaphic significance.

In some soils at the very foot of the lower slopes, pale yellow and light grey subsoil matrix colours are sometimes found (e.g. Profile F4 H in Appendix). These indicate poor drainage, but if they occur below 20 inches they are disregarded for classification purposes. The area covered by such soils is very small.

The textures of these soils depend upon the proportion of sandstone and shale in the parent material. Because of colluvial mixing, the soils tend to be of similar texture from the crest to the toe of any particular slope, so that soil mapping unit boundaries frequently follow divides and drainage lines. This tendency is more marked where the topographic grain of the country runs parallel to the strike of the underlying rocks (i.e. roughly East-West), as the same beds then outcrop across the width of the slope thus minimising lateral variation in the parent materials.

These soils are subdivided according to texture into three mapping units, described below.

3.2.2 Yellow sandy clay: Bkn

These are the heaviest textured of the hill soils and usually consist of a sandy clay loam surface over a sandy clay subsoil. However there are some which have sandy loam surface textures, but these qualify for this unit if the texture is as heavy as sandy clay within the top 40

inches. Surface litter layers are usually thin, rarely more than $\frac{1}{2}$ inch. Either the yellow or the reddish yellow colour variants are found as described above, but yellowish red and light red subsoil mottles are commoner in these soils than in those of lighter texture. Apparent clay-skins are moderate to strong on the subsoil subangular blocky peds, and the subsoil consistence is usually slightly firm.

These soils are in the Bekenu family in the current Sarawak classification (Sarawak Soil Survey Staff, 1966). The reddish yellow colour variant is similar to the description of Labang series, except that it is rarely of sufficiently heavy texture (Wall, 1964 and 1966).

3.2.3 Yellow sandy clay loam: (Nyl)

The textural profile in these soils may consist of either a sandy loam surface over a sandy clay loam subsoil, or a loamy sand surface over a sandy loam, which grades to a sandy clay loam within 40 inches of the soil surface. Surface litter layers are moderately thin, usually in the range $\frac{1}{4}$ - $\frac{3}{4}$ inches. Both the yellow or reddish yellow colour variants are found, but yellowish red and light red mottles are less common than in the sandy clays. Apparent clayskins are common on the subsoil subangular blocky peds, but they are generally thin and discontinuous. Subsoil consistence is usually friable to slightly firm.

These soils come in Nyalau family in the current classification (Sarawak Soil Survey Staff, 1966). The reddish yellow colour variant seems to fit the description of Nyalau series, but the yellow coloured soils are more like Likau series (Wall, 1964, and 1966).

3.2.4 Yellow sandy loam: (Pnj)

These are the lightest textured of the hill soils. The profile may consist of a loamy sand surface over a sandy loam subsoil, or the texture may be sandy loam throughout, from the surface to more than 40 inches. Surface litter layers are thicker than in the heavier textured soils, usually between $\frac{1}{2}$ and $1\frac{1}{2}$ inches thick. Both the yellow and reddish yellow colour variants are found but colours redder than Munsell hue 7.5YR are rare. There are frequently no visible clayskins and the subsoil subangular blocky structure may grade towards structureless (single grain). Subsoil consistence is friable or, rarely, loose.

These soils are also in Nyalau family in the current classification, but are light textured enough to qualify for Peninjau series in the more detailed classification of Wall (1965 and 1966).

3.3 Alluvial soils: Tata/Kyn

There are narrow strips of alluvial or gully wash material along the streams. This material may be quite shallow especially in the upper reaches and hard rock is often encountered at less than 40 inches. The material is mostly coarse grained and heavy textured soils are rare.

Poorly drained wet soils with light grey or pale yellow matrix colours appearing in the top 20 inches are the most widespread. These fall in Tatau family of the Gley great soil group in the current classification if there is no thin surface peat or muck layer. Otherwise similar soils with such a layer qualify for Matu family, but these are not common in the Reserve.

Soils which are relatively well drained, and in which the matrix colours of the top 20 inches are yellow, brown or red, qualify for Kayan family in the Recent Alluvial great soil group. In this area, they generally show signs of gleying within auger depth, but there are some which are apparently well drained to below 40 inches.

The soils of Tatau, Matu and Kayan families are easily distinguished in the field, but they occur in such an intricate pattern that it has not been possible to map them separately, so they appear as a Tatau/Kayan Complex in Map 1.

There are soils which are thought to be currently in transition from Kayan to Tatau family. The change is caused by the raising of the watertable in some of the vallies by road construction downstream. A good example is the unnamed stream that flows eastwards just outside the southern boundary of the Reserve. This is crossed by the Bakam feeder road at Mile 2, and a culvert was constructed, in preference to a more expensive bridge. As is often the case, the culvert is adequate to cope with peak flows, but for normal water levels it is placed rather too high. This has resulted in an impedence of the external drainage of the whole catchment upstream. The watertable has been raised sufficiently to kill off the empran forest that formerly grew on the alluvial soils. Similar areas of dead trees are a common sight along recently constructed Sarawak roads, and may be inevitable without considerable increases in construction costs.

In addition to the raising of the water table, road construction has also upset the 'natural dynamics' of the valley areas by causing greatly increased sedimentation. This can be attributed to two separate sets of factors. Firstly the high placing of the culverts impedes external drainage of the areas upstream. This reduces the velocity and hence the capacity of the stream. Secondly, road construction involves the removal

of large areas of protective vegetation and topsoil, so that the rate of surface detachment by water erosion is greatly increased. This is especially marked in the road fillings, in which the poor quality fill derived from the Miri and Tukai Formations **has been used**. In some of these embankments, gullies of 6 feet width and 8 feet depth have already appeared. The 1962-3 landslips in the rest of the area also contribute to the increase in mass waste.

The combination of the greatly increased volume of material and the reduction in the stream's capacity to transport it, leads to rapid silting up of the valley bottom. In one place in the southwestern part of the Reserve, a valley of about 5 chains width is covered with raw, recent alluvium to 6-18 inches depth. The original soil surface is still clearly distinguishable beneath this material. The main areas of the Tatau/Kayan complex affected by this recent silting are shown on Map 1.

3.4 Disturbed land

This mapping unit covers those areas that have been subject to recent catastrophic disturbance and which are easily delineated on the 1967 1:18,000 aerial photographs. Thus the actual road, cuttings and embankments of the Bakam feeder road, and the larger landslip sites are included. Smaller landslips cannot easily be distinguished on such small scale photography and have been disregarded, even where they were actually seen in the field.

The tractor paths made during the logging operations are also omitted. Even those in existence at the time of the 1967 photography are not all visible and, since then, many new paths have been cleared. However, although not shown on the map, it is thought that land whose surface is more or less severely disturbed by the timber operations may cover a considerable fraction of the total area. In Sabah figures in excess of 40% are known (Fox, 1966). It is hoped that the fraction is lower in Sarawak conditions, and tractor paths cover about 10% of the land surface in an exploited area in the Niah Forest Reserve (J.R. Palmer, pers. comm., 1970).

	Yellowish brown surface, over yellow yellow sandy clay weathering rock at	
(b)(2)	Yellowish brown to brownish or white soil, with occasional angular rock at	
(b)(3)	Yellowish brown to yellow, brownish subsoil, with angular rock generally	
	Coarse textured clay, shaly with 20 feet post or sub	
Tatau/Kayan	Coarse textured clay, shaly with 20 feet or less & thin post or weak layers	
	Coarse textured clay and fine yellow, brown for at least 20 inches	
III	Disturbed land	

Notes: (1) According to recent classification (1966).
 (2) According to (1966).
 (3) This area includes that part of the road reserve separating the two parts of Bakam.

Summary of soil mapping units, Bakam Road S.R.

Mapping Unit	Brief Description	Sarawak Classification			Area (acres)	Representatives Profiles (see Appendix)
		Great Soil Group (1)	Family (1)	Series (2)		
Bkn	Yellowish brown sandy loam or sandy clay loam surface, over yellow, brownish or reddish yellow sandy clay subsoil with strong clayskins. Weathering rock generally at 20-40 inches.	Red Yellow Podsollic	Bekenu	-	159	F4F
(Nyl)	Yellowish brown sandy loam surface, over yellow, brownish or reddish yellow sandy clay loam subsoil, with moderate-weak clayskins. Weathering generally rock at 20-40 inches.	Red Yellow Podsollic	Nyalau	Nyalau (reddish yellow), or Likau (yellow)	280	F4A, F4B, F4J (Nyalau) F4G (Likau)
(Pnj)	Yellowish brown loamy sand or sandy loam over yellow, brownish or reddish yellow sandy loam subsoil, with weak-absent clayskins. Weathering rock generally at 20-40 inches.	Red Yellow Podsollic	Nyalau	Peninjau	31	F4E
Tta/ Kyn	Coarse textured alluvium which is wet and gleyed within 20 inches of surface. No surface peat or muck layer.	Gley	Tatau	-	81	-
	Coarse textured alluvium which is wet and gleyed within 20 inches of the surface and which has a thin (always less than 10 inches) peat or muck layer at surface.	Gley	Matu	-		-
DL	Coarse textured alluvium which is well drained and has yellow, brown or red matrix colours for at least 20 inches from surface.	Recent Alluvial	Kayan	-	42 (3)	-
	Disturbed land	-	-	-		42 (3)
					<u>Total</u>	594 (3)

Notes:

- (1) According to current Sarawak classification (Sarawak Soil Survey Staff 1966).
- (2) According to Wall (1966).
- (3) These areas includes that part of the road reserve separating the two parts of Reserve.

Profile F4A

Mapping unit: (Nyl) (Map 8) G.S.G. Family Series
Sarawak classification: Red Yellow Podsolc 2 Nyalau Nyalau
Location: Close to plot 8 on Lambir site (see Map 8).
Topography: Upper slope (gradient 20 - 25°).
Parent material: Miri/Tukau Formation soft fine sandstone.
Vegetation: Originally Mixed Dipterocarp Forest - now thick secondary growth.

0-2 2.5Y 7/4 (pale yellow) with many medium distinct 7.5YR N3/ (very dark grey) and few fine faint 10YR 6/3 (pale brown) mottles, sandy loam, moderate medium granular with very weak discontinuous clay-skins [10YR 7/4 (very pale brown)], moist, friable, slightly porous, many roots.

Gradual regular boundary

2-5 2.5Y 7/4 (pale yellow) with many medium distinct 10YR N3/ (very dark grey) and few fine faint 7.5YR 5/8 (strong brown), 10YR 6/3 (pale brown) mottles, sandy loam - sandy clay loam, weak fine subangular blocky with weak discontinuous clayskins [10YR 7/4 (very pale brown)], moist, firm, slightly porous, many roots.

Diffuse boundary

5-19 2.5Y 8/4 (pale yellow) with few fine faint 5Y 7/3 (pale yellow), 2.5Y 6/2 (light brownish grey) mottles, sandy clay loam, weak fine subangular blocky with weak discontinuous clayskins [10YR 6/3 (pale brown)], moist, firm, porous, few roots.

Gradual regular boundary

19-34 2.5Y 8/4 (pale yellow) with few fine faint 2.5Y N7/ (light grey) and 2.5Y 6/4 (light yellowish brown) mottles, sandy clay loam, moderate medium subangular blocky with moderate continuous clayskins [10YR 7/4 (very pale brown)], moist, firm, very slightly porous, few roots, common old root channels filled with mixed 2.5YR 6/2 (dark grey) and 10YR 5/2 (greyish brown) sandy loam.

Gradual wavy boundary

34-42 10YR 8/6 (yellow) with few fine faint 7.5YR 5/8 (strong brown) and 2.5Y N7/ (light grey) mottles and few faint rusty root channels, sandy clay loam, moderate medium subangular blocky with weak continuous clayskins [2.5Y 7/4 (pale yellow)], moist, firm, slightly porous, roots absent.

Gradual wavy boundary

42-62 10YR 6/8 (brownish yellow) with common medium distinct 2.5YR N7/ (light grey) and few fine faint 7.5YR 5/8 (strong brown) mottles, sandy clay loam, weak medium subangular blocky with weak discontinuous clayskins [2.5Y 7/4 (pale yellow)], moist, firm, slightly porous, roots absent, common stones of slightly hard pale yellow, dark red and dark reddish brown iron-stained sandstone.

Gradual regular boundary

62-74+ 2.5Y 7/4 (pale yellow) with common medium distinct 7.5YR N7/ (light grey) and 10YR 6/8 (yellowish brown) mottles, sandy clay loam - sandy clay, weak moderate subangular blocky with weak discontinuous clayskins [10YR 7/4 (pale brown)], moist, firm, non-porous, roots absent, many stones of hard dark brown pipestone and slightly hard - hard strong brown, reddish yellow and weak red iron-stained sandstone.

Profile F4A (contd.)

Depth (inches)	pH H ₂ O	% Org. C	% Total N	Conc. HCl Extract					% of fine earth					Texture
				P ppm	Ca ppm	Mg ppm	K ppm	Group III%	Coarse sand	Medium sand	Fine sand	Silt	Clay	
0 - 2	4.4	1.3	0.09	60	60	610	1930	3.8	0.1	2.5	67.1	16.7	14.5	Sandy loam
2 - 5	4.4	0.8	0.08	75	80	660	2220	3.5	0.4	1.9	66.3	16.9	14.5	Sandy loam
10-12	4.5	0.5	0.05	60	61	730	2360	3.9	0.2	2.0	63.1	15.5	17.0	Sandy loam
26-28	4.7	0.2	0.04	60	61	856	3100	5.1	0.1	1.7	60.0	16.9	22.1	Sandy clay loam
37-39	4.7	0.1	0.04	80	80	1020	3050	5.1	0.2	1.4	59.2	14.0	23.7	-ditto-
50-52	4.7	0.1	0.04	90	60	1160	4320	8.1	1.1	1.7	52.5	15.2	30.9	-ditto-
70-73	4.6	0.1	0.06	110	60	1470	4500	8.2	5.2	2.0	40.4	19.1	32.6	-ditto-

Exchangeable me./100gms.					
	Ca	Mg	K	Na	CEC
Sample 1	3.1	4.5	0.1	Tr	5.0
2	0.2	0.3	0.1	Tr	4.4
3	0.1	0.1	0.1	Tr	4.2
4	0.1	0.1	0.1	Tr	4.0
5	0.2	0.1	0.1	Tr	9.2
6	0.3	0.1	Tr	Tr	5.3
7	0.1	0.1	0.1	Tr	10.4

Profile F4E (contd.)

Sample No.	Depth (inches)	pH H ₂ O	% Org. C	% Total N	Conc. HCl Extract					% of fine earth					Texture
					P ppm	Ca ppm	Mg ppm	K ppm	Group III %	Coarse sand	Medium sand	Fine sand	Silt	Clay	
	0 - 2	4.5	1.7	0.14	100	30	510	1380	1.7	0.6	9.6	61.6	22.9	12.0	Sandy loam
	2 - 5	4.5	0.8	0.07	60	10	510	1470	2.5	0.7	8.9	58.7	19.6	13.0	Sandy loam
	5 - 7	4.6	1.3	0.07	50	10	540	1380	2.6	0.7	8.1	51.1	10.1	23.4	Sandy clay loam
	10-13	5.1	0.4	0.05	60	30	710	1910	3.2	0.7	7.2	60.0	13.3	22.7	Sandy clay loam
	16-19	5.1	0.7	0.07	60	40	770	2150	3.7	0.6	8.3	56.7	13.7	21.12	Sandy clay loam
	28-31	5.1	0.1	0.03	50	30	680	1650	3.3	0.6	8.5	64.1	12.5	18.85	Sandy loam
	42-44	4.0	Tr	0.03	60	30	680	1640	2.9	0.7	8.8	67.6	12.7	18.06	Sandy loam
	68-71	4.1	0.1	0.04	70	50	1040	2790	4.6	0.6	5.9	58.7	14.2	25.1	Sandy loam - sandy clay loam

... (faint text describing soil characteristics and boundaries) ...

Diffuse boundary

... (faint text) ...

Gradual slightly very boundary

... (faint text) ...

Clear very boundary

... (faint text) ...

Gradual slightly very boundary

... (faint text) ...

Very hard fine sandstone.

Profile F4F

Mapping unit: Bkn G.S.G. Family
Sarawak classification: Red Yellow Podsollic Bekenu
Location: Chain 14 on rentis 6N (just north of afforestation trial site - see Map 1).
Topography: Midslope of low hill.
Parent material: Miri or Tukai Formation sandstone.
Vegetation: Recently logged Mixed Dipterocarp Forest.

½-0 5YR 3/3 (dark brown) litter.

0-3 10YR 7/4 (very pale brown) with few fine faint 10YR 7/8 (yellow) mottles, fine sandy loam, weak fine crumb, dry, loose, slightly porous, abundant roots.

Gradual regular boundary
3-10 10YR 6/6 (brownish yellow) with few fine faint 2.5Y 7/2 (light grey) mottles, fine sandy clay loam, weak fine subangular blocky with clayskins [10YR 5/4 (yellowish brown)] especially along root channels, moist, soft, slightly porous, many roots.

Gradual irregular boundary
10-24 10YR 7/8 (yellow) with few fine faint 2.5Y 7/4 (pale yellow) mottles, fine sandy clay to fine sandy clay loam, moderate medium subangular blocky with weak discontinuous clayskins [10YR 5/6 (yellowish brown)] especially along old root channels, moist, slightly firm, porous, many roots.

Diffuse boundary
24-34 10YR 7/6 (yellow) with few fine faint 5Y 7/6 (reddish yellow) mottles, fine sandy clay, moderate medium coarse subangular blocky with strong continuous clayskins [10YR 6/8 (brownish yellow)], moist, firm, slightly plastic, slightly sticky, very porous, roots common.

Gradual slightly wavy boundary
34-43 7.5YR 7/6 (reddish yellow), medium to fine sandy clay, moderate medium subangular blocky with strong continuous clayskins [7.5YR 6/6 (reddish yellow)], moist, firm, very porous, few roots, few small pieces of fine sandstone.

Clear wavy boundary
43-53 2.5YR 6/8 (light red) with many fine distinct 2.5Y N7/ (light grey) and 2.5Y 8/4 (pale yellow) mottles, medium sandy clay to medium sandy clay loam, moderate medium subangular blocky with moderate discontinuous clayskins [5YR 7/8 (reddish yellow)], moist, firm, slightly porous, roots rare, common hard to slightly hard pieces of 2.5YR 4/8 (red), 2.5YR 3/6 (dark red) fine sandstone and sand.

Gradual slightly wavy boundary
53-57 As above but mottles increase to many medium, and stones decrease to few.

57+ Very hard fine sandstone.

Profile F4F (contd.)

Depth (ins.)	pH H ₂ O	% Org. C	% Total N	Conc. HCl Extract					% of fine earth					Texture
				P ppm	Ca ppm	Mg ppm	K ppm	Group III %	Coarse sand	Medium sand	Fine sand	Silt	Clay	
0 - 3	3.5	2.1	0.18	70	10	380	720	1.7	0.2	4.2	62.1	19.5	20.4	Sandy loam
4 - 6	3.4	0.8	0.07	80	10	400	670	2.5	0.3	4.0	61.0	21.5	25.6	Sandy loam
14-17	3.7	0.3	0.05	60	50	540	1210	3.8	0.2	4.0	62.2	21.6	20.5	Sandy loam
26-29	4.2	0.1	0.18	50	40	650	1660	4.7	0.2	3.9	60.7	21.7	18.2	Sandy loam
39-43	4.5	Tr	0.02	50	30	570	1360	3.6	0.5	3.9	63.1	20.1	18.7	Sandy loam
46-49	4.7	Tr	0.04	60	190	960	2750	8.5	3.7	4.2	50.4	18.3	29.3	Sandy clay loam
54-57	4.7	0.1	0.04	70	100	1050	2940	7.2	0.8	3.7	50.4	19.4	31.8	Sandy clay loam

12-17 Gradual irregular boundary
10W 2/8 (yellow) with few fine roots of 2/7 (light gray) and
2.5T 7/8 (pale yellow) nodules, fine sandy clay, moderate
medium subangular blocky, weak, slightly porous, few roots, few
2.5T 7/8 (yellowish red), 2.5T 8/8 (orange brown) fine subangular
blocky nodules.

17-42 Gradual irregular boundary
10W 2/8 (yellow) with few fine roots of 2/7 (light gray) and
2.5T 7/8 (pale yellow) nodules, fine sandy clay, moderate
medium subangular blocky, weak, slightly porous, few roots, few
2.5T 7/8 (yellowish red), 2.5T 8/8 (orange brown) fine subangular
blocky nodules.

47-45 Gradual slightly wavy boundary
10W 4/6 (orangeish yellow) with few fine roots of 2/7 (light gray) and
2.5T 7/8 (pale yellow) nodules, fine sandy clay, moderate
medium subangular blocky, weak, slightly porous, few roots, few
2.5T 7/8 (yellowish red), 2.5T 8/8 (orange brown) fine subangular
blocky nodules.

60-73 Gradual slightly wavy boundary
10W 2/8 (yellow) with many medium distinct 2.5T 7/8 (yellow),
2.5T 8/8 (light gray) nodules, fine sandy clay, moderate medium
subangular blocky, weak, fine, slightly porous, many fine to
slightly hard angular - subangular pieces of 2.5T 7/8 (orange
brown) and (orange) medium nodules.

Profile F4G

Mapping unit: (Ny1) G.S.G. Family Series
Sarawak classification: Red Yellow Podsollic Nyalau Likau
Location: Chain 17 on rentis 3N (see Map 1).
Topography: Midslope of strike aligned ridge (gradient ca 30°).
Parent material: Miri or Tukau Formation sandstone.
Vegetation: Recently logged Mixed Dipterocarp Forest.

- 0-2 10YR 5/3 (brown) with few fine distinct 10YR 7/1 (light grey) mottles and many bleached coarse sand grains, fine sandy loam, structureless - massive, moist, loose, non porous, many roots.
- 2-5 Clear slightly wavy boundary
10YR 5/6 (yellowish brown) with many medium distinct 2.5Y N7/ (light grey), 7.5YR 7/8 (reddish yellow) mottles, fine sandy loam, very fine subangular blocky with weak discontinuous clayskins [10YR 6/3 (pale brown)] especially along root channels, moist, slightly firm, very porous, common roots, few small soft pieces of 2.5YR 4/6 (red) fine sandstone.
- 5-12 Clear slightly wavy boundary
10YR 6/8 (yellow) with few fine faint 5Y 7/3 (pale yellow), and 7.5YR 7/8 (reddish yellow) mottles, fine sandy clay to fine sandy clay loam, weak fine subangular blocky with moderate continuous clayskins [2.5Y 7/4 (pale yellow)], moist, slightly firm, very porous, few roots, few slightly hard angular - subangular fragments of 5YR 5/8 (yellowish red), 2.5YR 5/4 (reddish brown) fine sandstone.
- 12-27 Gradual irregular boundary
7.5YR 7/8 (yellow) with few fine faint 2.5Y N7/ (light grey) and 5Y 7/3 (pale yellow) mottles, medium to fine sandy clay, moderate medium subangular blocky with strong continuous clayskins [10YR 7/4 (very pale brown)], moist, firm, very porous, few roots, few hard to slightly hard subangular pieces of 5YR 4/8 (yellowish red), 10R 3/3 (dusky red), 2.5YR 5/6 (red) sandstone.
- 27-47 Gradual irregular boundary
10YR 7/8 (yellow) with few fine faint 2.5Y N7/ (light grey) and 5Y 7/3 (pale yellow) mottles, medium sandy loam to sandy clay loam, moderate medium subangular blocky, moist, slightly firm, slightly porous, roots rare, common stones - as above.
- 47-65 Gradual slightly wavy boundary
10YR 6/6 (brownish yellow) with few fine faint 5Y 7/3 (pale yellow) mottles, medium to coarse sandy loam to sandy clay loam, weak - medium subangular blocky, moist, firm, slightly porous, roots absent, many very soft pieces of 7.5YR 7/8 (reddish yellow) and orange coarse sandstone, and hard pieces of 10R 3/3 (dusky red) sandstone.
- 65-73+ Gradual slightly wavy boundary
10YR 7/8 (yellow) with many medium distinct 2.5Y 7/6 (yellow), 2.5Y N7/ (light grey) mottles, fine sandy clay, moderate medium subangular blocky, moist, firm, slightly porous, many hard to slightly hard angular - subangular pieces of 7.5YR 5/8 (strong brown) and (orange) medium sandstone.

Profile F4G (contd.)

Depth (ins.)	pH	% H ₂ O 2	% Org. C	% Total N	Conc. HCl Extract					% of fine earth					Texture
					P ppm	Ca ppm	Mg ppm	K ppm	Group III %	Coarse sand	Medium sand	Fine sand	Silt	Clay	
0 - 2	4.6	1.7	0.02	70	50	410	1310	1.9	1.0	9.3	65.3	12.1	16.8	Sandy loam	
3 - 5	4.7	0.5	0.06	60	30	540	1760	2.6	0.8	8.1	61.1	14.9	19.2	Sandy loam	
7 - 10	4.6	0.2	0.04	70	60	880	2620	4.7	1.0	7.0	52.7	15.9	27.4	Sandy clay loam	
18-21	4.7	0.1	0.04	80	220	1220	3160	5.7	1.7	7.0	50.0	15.7	29.6	Sandy clay loam	
34-37	4.7	0.1	0.02	50	190	660	2080	3.4	2.1	32.0	43.0	7.7	16.9	Sandy loam	
52-55	4.9	0.1	0.02	50	220	510	1580	3.7	12.7	44.4	25.1	5.4	15.1	Sandy loam	
70-73	4.6	0.8	0.03	60	230	690	2650	5.2	8.3	18.8	44.0	10.4	20.6	Sandy loam - sandy clay loam	

continuous clayskins (10YR 7/4 very pale brown), moist, slightly firm, very porous, common roots.

23-25 Gradual slightly wavy boundary
10YR 7/6 (yellow) with wavy nodules to coarse distinct 7.5YR 6/1 (light grey), 7.5YR 6/2 (reddish yellow), and few fine faint 2/2 (light grey) mottles, medium sandy clay, moderate nodules sub-angular blocky with weak discontinuous clayskins (10YR 7/4 (very pale brown)), especially along old root channels, moist, firm, very porous, few roots.

32-49 Gradual slightly wavy boundary
Mixed distinct 7.5YR 6/1 (light grey), 7.5YR 6/2 (reddish yellow), 5Y 7/2 (light grey), medium sandy clay, moderate nodules to coarse sub-angular blocky with weak discontinuous clayskins (2.5Y 7/4 (pale yellow)), moist, firm, very porous, wavy rusty old root channels but roots rare.

40-60 Gradual irregular boundary
As above, but no clayskins, and wavy angular to sub-angular fragments of very hard to slightly hard 5Y 5/2 (dark reddish brown), 2.5Y 3/5 (dark red) and 5YR 3/3 (yellowish red) fine sandstone, with few pieces of pipe stone.

60+ Very hard sandstone, colour as above.

Profile F4H

Mapping unit: (Nyl) G.S.G. Family Phase
Sarawak classification: Red Yellow Podsollic Bekenu Imperfectly
drained

Location: Chain 10 on rentis 10S (see Map 1).

Topography: Lower slope, bordering upper dry gully (gradient 15°).

Parent material: Miri or Tukau Formation sandstone.

Vegetation: Secondary forest with high proportion of *Macaranga* spp.

½-0 7.5YR 4/2 (dark brown) litter.

0-3 10YR 6/3 (pale brown) with few fine faint 5Y 7/3 (pale yellow) mottles, fine sandy loam, very weak fine subangular blocky, moist, friable, very porous, many roots.

Gradual slightly wavy boundary

3-11 10YR 7/6 (yellow) with few fine faint 10YR 7/1 (light grey), 7.5YR 7/8 (reddish yellow) mottles, fine sandy clay loam to fine sandy clay, weak medium subangular blocky with weak discontinuous clayskins [10YR 7/4 (very pale brown)] especially along old root channels, moist, slightly firm, very porous, many roots.

Gradual irregular boundary

11-23 2.5Y 7/4 (pale yellow) with few medium distinct 10YR 7/1 (light grey), 7.5YR 6/6 (reddish yellow) mottles, fine sandy clay to medium sandy clay, weak medium subangular blocky with moderate continuous clayskins [10YR 7/4 (very pale brown)], moist, slightly firm, very porous, common roots.

Gradual slightly wavy boundary

23-32 10YR 7/6 (yellow) with many medium to coarse distinct 7.5YR N7/ (light grey), 7.5YR 6/6 (reddish yellow), and few fine faint 5Y 7/2 (light grey) mottles, medium sandy clay, moderate medium subangular blocky with weak discontinuous clayskins [10YR 7/4 (very pale brown)] especially along old root channels, moist, firm, very porous, few roots.

Gradual slightly wavy boundary

32-49 Mixed distinct 7.5YR N7/ (light grey), 7.5YR 6/8 (reddish yellow), 5Y 7/2 (light grey), medium sandy clay, moderate medium to coarse subangular blocky with weak discontinuous clayskins [2.5Y 7/4 (pale yellow)], moist, firm, very porous, many rusty old root channels but roots rare.

Gradual irregular boundary

40-60 As above, but no clayskins, and many angular to subangular fragments of very hard to slightly hard 5YR 3/2 (dark reddish brown), 2.5YR 3/6 (dark red) and 5YR 5/8 (yellowish red) fine sandstone, with few pieces of pipe stone.

60+ Very hard sandstone, colours as above.

Profile F4H (contd.)

Sample No.	Depth (ins.)	pH H ₂ O	% Org. C	% Total N	Conc. HCl Extract					% of fine earth					Texture
					P ppm	Ca ppm	Mg ppm	K ppm	Group III %	Coarse sand	Medium sand	Fine sand	Silt	Clay	
1	0 - 3	4.7	1.5	0.14	90	120	660	1790	2.2	0.6	11.7	64.3	10.6	19.8	Sandy loam
2	5 - 8	4.7	0.4	0.06	70	110	740	1910	3.1	0.4	9.1	60.6	13.6	20.9	Sandy loam - sandy clay loam
3	15-18	4.7	0.3	0.04	70	120	900	2770	4.7	0.3	8.5	59.0	14.8	21.1	Sandy clay loam
4	25-28	4.6	0.2	0.04	40	130	990	2910	3.8	0.4	9.7	55.9	13.8	20.3	Sandy loam - sandy clay loam
5	38-41	4.8	0.2	0.04	80	140	1070	3140	4.1	0.5	9.3	52.8	15.7	26.0	Sandy clay loam
6	56-60	4.7	0.1	0.04	100	170	1030	3940	5.4	1.0	8.8	45.6	16.6	30.6	Sandy clay loam

Gradual regular boundary

10R 7/8 (yellow) to 7.5R 7/8 (reddish yellow) with common fine very faint 2.5Y 7/4 (pale yellow) mottles, fine sandy clay loam, moderate coarse subangular blocky with strong continuous clay skins [10R 8/8 (yellow)], moist, firm, slightly plastic, slightly porous, few roots, few pieces of hard iron 2.5Y 1/6 (dark red), 2.5Y 1/2 (dusky red), and 5R 1/3 (dark reddish brown) sandstone.

Gradual regular boundary

7.5R 6/8 (reddish yellow) with very medium distinct 2.5Y 5/7 (light grey) mottles, fine sandy clay loam, moderate coarse subangular blocky with moderate continuous clay skins [10R 8/8 (yellow)], moist to dry, firm, very slightly plastic non sticky, ped interiors are slightly porous, roots rare, few stones - as above.

Clear slightly wavy boundary

Mixed distinct 7.5YR 6/8 (reddish yellow) and 10YR 8/7 (light grey), fine to medium sandy clay loam, moderate coarse subangular blocky with weak discontinuous clay skins, moist to dry, firm, slightly plastic, non sticky, non porous, few roots, and few stones as above.

47-54 Colours as above, fine to medium sandy loam, moderate to weak medium subangular blocky, moist, slightly firm, non plastic, non sticky, very slightly porous, roots rare.

Gradual regular boundary

Mixed distinct (coarser patches than above) 7.5YR 6/8 (reddish yellow), 10YR 7/1 (light grey), 5YR 5/8 (yellowish), and 2.5Y 7/4 (pale yellow), medium sandy loam, weak medium subangular blocky, wet to moist, slightly friable, slightly porous, roots absent, few slightly hard pieces 10R 4/8 (red) medium sandstone.

Profile F4J

Mapping unit: (Nyl) G.S.G. Family Series
Sarawak classification: Red Yellow Podsollic Nyalau Nyalau
Location: Centre of variability trial, close to peg 17 on rentis
9N (see Map 1).
Topography: Midslope of low hill (gradient 27°).
Parent material: Miri or Tukau Formation sandstone.
Vegetation: Recently logged Mixed Dipterocarp Forest.

- 1-0 Dark brown litter.
- 0-2 10YR 6/4 (light yellowish brown) with very few fine very faint 10YR 7/1 (light grey) mottles, fine sandy loam, weak fine subangular blocky, moist, friable, porous, many roots.
- Gradual wavy boundary
- 2-4 2.5Y 7/4 (pale yellow) with common medium distinct 10YR 7/1 (light grey), and few fine very faint 2.5Y 8/4 (pale yellow) mottles, fine sandy loam, moderate medium subangular blocky, moist, porous, common roots.
- Clear wavy boundary
- 4-16 10YR 8/8 (yellow) with few fine very faint 2.5Y 8/4 (pale yellow) mottles, fine sandy loam to fine sandy clay loam, moderate medium subangular blocky with very weak discontinuous clayskins, moist, slightly firm, slightly plastic, non sticky, slightly porous, common roots.
- Gradual regular boundary
- 16-35 10YR 7/8 (yellow) to 7.5YR 7/8 (reddish yellow) with common fine very faint 2.5Y 7/4 (pale yellow) mottles, fine sandy clay loam, moderate coarse subangular blocky with strong continuous clayskins [10YR 8/8 (yellow)], moist, firm, slightly plastic, slightly porous, few roots, few pieces of hard medium 2.5YR 3/6 (dark red), 2.5YR 3/2 (dusky red), and 5YR 3/3 (dark reddish brown) sandstone.
- Gradual regular boundary
- 35-42 7.5YR 6/8 (reddish yellow) with many medium distinct 2.5Y N7/ (light grey) mottles, fine sandy clay loam, moderate coarse subangular blocky with moderate continuous clayskins [10YR 8/8 (yellow)], moist to dry, firm, very slightly plastic non sticky ped interiors are slightly porous, roots rare, few stones few stones - as above.
- Clear slightly wavy boundary
- 42-47 Mixed distinct 7.5YR 6/8 (reddish yellow) and 10YR 7/1 (light grey), fine to medium sandy clay loam, moderate coarse subangular blocky with weak discontinuous clayskins, moist to dry, firm, slightly plastic, non sticky, non porous, few roots, and few stones as above.
- 47-54 Colours as above, fine to medium sandy loam, moderate to weak medium subangular blocky, moist, slightly firm, non plastic, non sticky, very slightly porous, roots rare.
- Gradual regular boundary
- 54-68 Mixed distinct (coarser patches than above) 7.5YR 6/8 (reddish yellow), 10YR 7/1 (light grey), 5YR 5/8 (yellowish red), and 2.5Y 7/4 (pale yellow), medium sandy loam, weak medium subangular blocky, wet to moist, slightly friable, slightly porous, roots absent, few slightly hard pieces 10R 4/8 (red) medium sandstone.
- Abrupt wavy boundary
- 68-72+ Compact, slightly hard 10YR 6/2 (light brownish grey) weathering medium sandstone, with common medium distinct patches of 7.5YR 5/6 (strong brown).

Profile F4J (contd.)

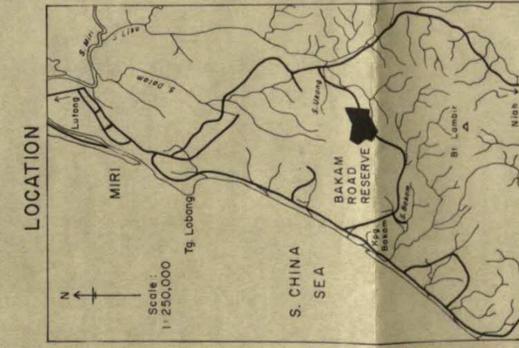
Sample No.	Depth (ins.)	pH H ₂ O	% Org. C	% Total N	Conc. HCl Extract					% of fine earth					Texture
					P ppm	Ca ppm	Mg ppm	K ppm	Group III %	Coarse sand	Medium sand	Fine sand	Silt	Clay	
1	0 - 2	4.4	1.5	0.11	70	100	590	2180	2.9	0.2	4.7	60.0	15.9	23.1	Sandy clay loam
2	2 - 4	4.6	1.0	0.10	70	100	780	2630	3.3	0.1	4.4	56.8	16.7	23.3	Sandy clay loam
3	8 - 12	4.9	0.3	0.05	70	120	860	2760	4.1	0.2	4.1	55.7	16.7	25.2	Sandy clay loam
4	24-28	4.8	0.2	0.04	90	120	1410	3710	6.3	0.4	3.8	47.3	16.3	34.3	Sandy clay loam
5	37-40	4.7	0.1	0.04	100	170	1020	4170	6.9	1.2	3.5	49.8	16.3	30.5	Sandy clay loam
6	44-46	4.9	0.1	0.04	70	120	770	3170	4.7	1.0	2.4	59.3	14.1	26.1	Sandy clay loam
7	49-52	4.9	0.1	0.03	60	80	810	2910	4.5	0.4	3.9	61.2	13.5	22.1	Sandy clay loam
8	59-63	4.6	0.1	0.03	50	120	600	2420	3.8	0.4	5.3	72.9	12.0	18.1	Sandy loam

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Bakam Road Silvicultural Research Reserve SOILS



KEY

- Boundary of Reserve. } See text.
- Boundary of Road Reserve.
- Road, with mile post (distances from main Miri - Niah Road).
- Form line (feet).
- Soil survey rents.
- Soil profile pit.
- Experimental afforestation site (for detailed soil survey, see map 2).
- Soil variability sample (see map 3).

SOIL MAPPING UNITS

Bkn	Yellow or reddish sandy clay loam over sandy clay.
(Ny1)	Yellow or reddish yellow sandy loam over sandy clay loam.
(Pn1)	Yellow or reddish yellow loamy sand over sandy loam.
Tlu/Kyn (b)	Mixed well and poorly drained coarse textured alluvial soils. (b) Covered with recent coarse sand deposits.
	Recently disturbed land.

