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PROJECT REPORT

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Land Use and Fisheries

DPI QUEENSLAND
DEPARTMENT OF PRIMARY INDUSTRIES

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SUMMARY

The development of the Burdekin River Irrigation Area (BRIA) in the Lower Burdekin Valley of North Queensland has accelerated since the Burdekin Falls Dam was completed in 1987. The first irrigation farms in the area were released in 1988, and up to the end of 1993, 89 farms have been sold. To date, most of the development has occurred on the Left Bank of the BRIA.

A substantial financial input is required to construct the Elliot Main Channel (EMC) through Stokes Range and eastwards towards the Elliot River on the Right Bank of the BRIA. Knowledge of the extent of suitable lands in the potential irrigable area below the proposed channel, is important to make sound decisions for further irrigation development on the Right Bank.

A 1:25 000 soil survey and land suitability assessment have been undertaken from Stokes Range to Yellow Gin Creek. However, information on the irrigated suitability of land between Yellow Gin Creek and Elliot River was inadequate to make sound irrigation planning decisions. A study was therefore undertaken in this area to classify the land into three categories: suitable, marginal and unsuitable for the furrow irrigation of sugar-cane. With the results from the survey from Stokes Range to Yellow Gin Creek as well as investigations into the groundwater regime of the area, this study will provide sufficient information for final irrigation planning for the Right Bank of the BRIA. For convenience, the area was divided into Stage I and Stage II.

The study found that about 15 000 ha of potential irrigated lands from Yellow Gin Creek to Elliot River (40 149 ha) are suitable for the furrow irrigation of sugar-cane. This represents about 50 percent of the area between Yellow Gin and Molongle Creeks (Stage I) and about 25 percent of the area between Molongle Creek and the Elliot River (Stage II).

The area assessed as suitable includes small isolated areas which may not be sufficiently large for farm subdivision, especially when adjacent to degraded areas. Some suitable lands also lie above the proposed location of the EMC, so the assessment overestimates the area suitable for gravity fed irrigation.

Large contiguous areas of suitable land lie between Yellow Gin and Wangaratta Creeks; on both sides of Rocky Ponds and Molongle Creeks; and west of the Elliot River close to the coast.

Most of the suitable lands are occupied by cracking clays with 9 179 ha on the local alluvial plains and associated pediments and 1 498 ha on another alluvial plain. Duplex soils and other soils on levees and fans of the major streams on the alluvial plains make up the remaining suitable land.

Marginal soils include the red and yellow duplex soils of the intake areas on the undulating rises on an intrusive rock complex. These rises make up a large proportion of the area between Slater and Wilson Creeks. These soils also occur near the southern boundary and as isolated areas, especially in Stage II. A large area of other marginal

soils occurs on the alluvial plains in Stage II between Armstrong and Big Jack Creeks. Extreme complexity in soils and relief limits the usefulness of this area.

Much of the surveyed area is actively eroding. This is due to gullying or channelling by overbank flooding. These areas are regarded as unsuitable and comprise about 30 percent of the area.

The suitability assessment did not consider either the present height of groundwater tables or their potential rise under irrigation. More lands nearer the coast may be downgraded if their groundwater tables are already close to the surface, since they will rise further on irrigation development. This assessment will have to be made in conjunction with ground water investigations by Water Resources.

INTRODUCTION

The Elliot Main Channel (EMC), on the Right Bank of the Burdekin River Irrigation Area (BRIA), has been constructed to 12.8 km to service farms in the Leichardt Downs Section. Construction of the irrigation reticulation works on the southern part of Leichardt Downs (see figure 1) has been completed and the first farms were released in this area in February 1990.

A substantial financial input is required to construct the EMC through Stokes Range and then eastwards to the Elliot River to service potential farms on the eastern side of the Range. It is important, therefore, that appropriate investigations are undertaken in this area to assist in final irrigation planning.

A high intensity soil survey (1:25 000) and land suitability assessment similar to those undertaken in other areas of the BRIA, have been completed between Stokes Range and Yellow Gin Creek (Inkerman West and Central Sections of the BRIA). This study identified:

(i) areas of land suitable for the irrigation of a range of crops;

(ii) areas that are presently salinised or have the potential to become salinised;

(iii) intake areas of the undulating rises (Investigations have shown that irrigation of the highly permeable soils on these intake areas will elevate groundwater levels on the lower slopes of these rises and adjoining alluvial plains. Salinisation may result if water tables approach the surface);

(iv) areas affected by erosion.

Information such as the above is required throughout the remainder of the Right Bank to assist in final irrigation planning.

Although a low intensity survey (1:100 000 scale) has been undertaken on the Right Bank of the BRIA (Thompson 1977), the results of this study have not been consistent with those from the high intensity studies of Leichardt Downs and Inkerman Sections. This trend was expected to continue for the remainder of the Right Bank from Yellow Gin Creek to the Elliot River. In addition, a reconnaissance of the area also showed that substantial eroded and degraded areas had not been identified during the low intensity survey. A reassessment of the lands from Yellow Gin Creek to the Elliot River was therefore warranted to complete the investigations required to finalise the irrigation project planning on the Right Bank. This study would provide information on the area suitable for the furrow irrigation of sugar-cane, the extent and location of intake areas and those areas affected by salinisation and erosion.

This reassessment was conducted using aerial photo interpretation with ground checking limited to one observation to 150 to 200 ha. A map at 1:50 000 was produced, showing soil mapping units as well as the lands suitable for furrow irrigation of sugar-cane, marginal irrigation lands for sugar-cane and unsuitable lands.

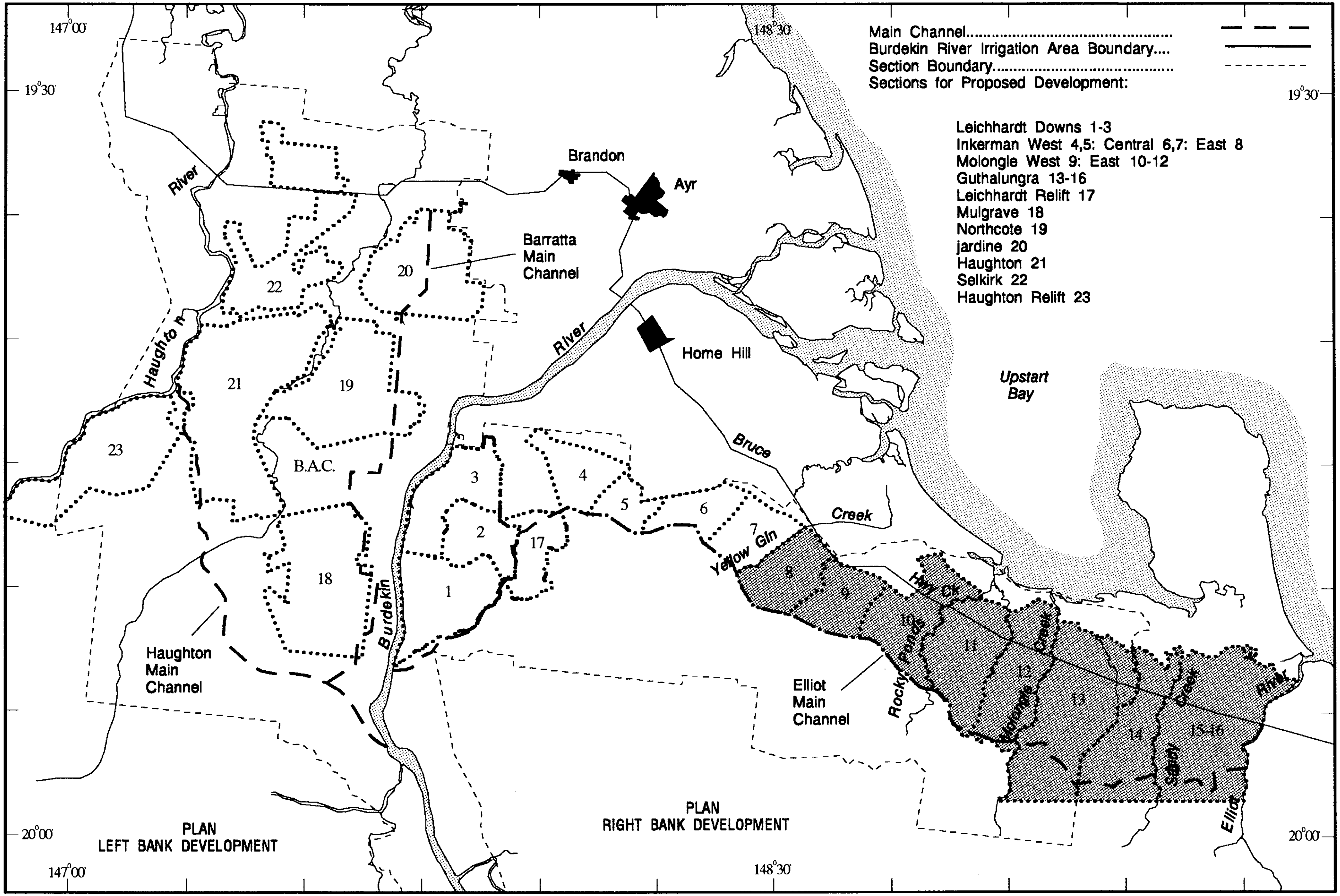

Figure 1. Burdekin River Irrigation Area general layout and location of Right Bank - Yellow Gin Creek to Elliot River Study

The study area extends from Yellow Gin Creek east to the Elliot River (Figure 1). It was divided into two Stages for ease of reporting, with Molongle Creek separating Stage I from Stage II. Stage I consists of Inkerman East and Molongle Sections of the BRIA subdivisions while the Guthalungra Sections make up Stage II.

The Bruce Highway from Yellow Gin to Arrow Creeks defines part of the northern boundary. The rest of this boundary is located near the saline marine flats. In Stage I, the southern boundary extends above the proposed EMC location. The southern boundary of Stage II is the northern boundary of the Elliot River-Bowen Area soils map (Aldrick 1988).

The areas of Stage I and Stage II are 20 349 ha and 19 800 ha respectively, making a total of 40 149 ha.

METHOD

Stereoscopic photo interpretation was carried out on coloured aerial photographs at a scale of 1:20 000 for Stage I and black and white aerial photos at 1:27 800 scale for Stage II. This interpretation identified provisional mapping units.

The provisional mapping units were checked in the field by observations along traverses located along roads, tracks, fence lines or power lines. Sites were described on these traverses to identify the landscape units[1] (LU) (formerly called topographic forms) and soils of the provisional mapping units. Landscape units 1, 3, 4, 5 and 6 were identified in this area and are briefly described in Table 1. A more detailed description of the LUs are given in Donnollan *et al.* (1990) and Thompson (1977). The site descriptions were recorded on the standard format suitable for later entry onto the Department of Primary Industries soils database.

Approximately 100 sites for each stage were recorded in this manner while other observations to check boundaries and identify small units were entered in a note book. This site density equates to a mapping scale between 1:50 000 and 1:100 000 based on the minimum density of 0.25 observations cm^{-2} of published map as suggested by FAO (1979). The sites were recorded on the appropriate aerial photograph and later identified by co-ordinates of the Australian Map Grid.

The soil profile described at each site was classified into soil types using the DPI soil classification system developed for the Lower Burdekin Valley (Thompson and Reid, 1982 and Loi *et al.* in press). Soil types with similar morphology and management requirements were then divided into soil groups. These soil groups were identified by an alpha numeric code: a number for the landscape unit and the appropriate subdivision of the dominant primary profile forms (Ug, Db, Um) (Northcote 1979). For example, soil group 1Ug denotes a cracking clay (Ug) on landscape unit 1.

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[1] A landscape unit is a natural unit of land in which a particularly soil or association of soils is developed from a single rock type or complex of rock types. The soils bear a constant relationship with a limited range of landform elements or native vegetation communities and there is a similar drainage net throughout the soil landscape (adapted from Thompson and Moore 1984).

Mapping units were then named after the dominant soil group. A single occurrence of a mapping unit was termed a Unique Map Area or UMA (after Basinski 1978). In complex areas where a singular soil group could not be mapped at the 1:50 000 scale, the UMA was named after the two most commonly occurring soil groups. Areas which are degraded, were named after the landscape unit number, followed by the letter E, for example, 3E identified eroded areas of landscape unit 3. Areas of rock outcrop were identified by the letter R after the landscape unit number. The letters SP after the landscape unit number identifies a swamp. Table 1 gives a brief description of the landscape units and the soil groups of the mapping units and shows the link with the DPI soil types and soil series names (Hubble and Thompson 1953).

Of the cracking clays, simple mapping units contain >70% of the soil group nominated. The mapping units of the undulating rises, especially the main ridge between Slater and Wilson Creeks, are estimated to be of similar purity. Other mapping units especially of LU6 would be less pure, especially in the complex area between Armstrong Creek and Big Jack Creek in Stage II.

The mapping units were assessed for their suitability to grow sugar-cane under furrow irrigation. Sugar-cane was assessed as it is more adaptable to a wider range of soils under furrow irrigation than other crops. The assessment, therefore, shows the maximum area available for furrow irrigation. A three-class system of suitability was used, that is, suitable (S), marginal (M), and unsuitable (U). The suitable category is equivalent to either classes 1, 2 or 3, the marginal category to class 4 and the unsuitable category to class 5. This five class system is currently used in the detailed soil survey program of the BRIA and class definitions are defined in Land Resources Branch staff (1990).

After finalising the mapping units, the name and the number of the UMA and the suitability symbol were inked onto the photos. All mapping and suitability information was subsequently transferred to the Land Resource Information System of the Department of Primary Industries. A combined map showing irrigated sugar-cane land suitability of Stage I and Stage II accompanies this report.

RESULTS

General description of area

The area consists predominantly of a number of depositional plains formed from a range of sediment sources of various ages. These alluvial landforms, namely landscape unit 1 (LU1), landscape unit 3A (LU3A) with Koberinga soils (Hubble and Thompson, 1953) and landscape unit (LU6), have been described in Donnollan (1990). Landscape unit 3B (LU3B) with Tolgai soils (Hubble and Thompson, 1953), described by Thompson (1977) as local alluvial plains - slightly elevated areas, is also present in the area. Thompson (1977) suggested that such plains are residual or relict and are elevated one to three metres higher than the other depositional plains. Landscape unit 3B is only located east of Wangaratta Creek, while the low lying subdivision with predominantly Koberinga soils (LU3A) is found west of Wangaratta Creek.

Table 1. A brief description of the landscape units and soil groups of the mapping units and the link with DPI soil types and soil series names.

Mapping unit	Landscape unit	Soil group	DPI soil types	Soil Series (a)
1Ug	Landscape unit 1 - Local alluvial plains and associated pediments.	Grey cracking clays	1Uga, 1Ugd, 1Uge with minor 1Ugc and 1Ugf	Barrunga, Lingilor
1Dy		Sodic duplex soils with grey B horizon	1 Dyc, 1Dyd with minor 1Dya and 1Dyb	Gaynor
3Ug	Landscape unit 3A - Local alluvial plains, west of Wangaratta Creek.	Black earths and grey cracking clays	3Uga, 3Ugd, with minor 3Ugc and 3Uge	Koberinga
3Ug	Landscape unit 3B - Relict alluvial plains east of Wangaratta Creek.	Grey cracking clays	3Ugh, 3Ugi, 3Ugj	Tolgai
3Dy		Sodic duplex soils with grey B horizon	3Dya	---
4Dy	Landscape unit 4 - Gently undulating rises on acid intrusive rocks, pediments and prior streams.	Sodic and non-sodic duplex soils with yellow or grey B horizon	4Dyg, 4Dyc with minor 4Dyb and 4Dyi	Bambave, Mulgrave
5Ug	Landscape unit 5 - Gently undulating rises on an intrusive rock complex.	Black earths and grey cracking clays	5Uga, 5Ugb	Wyong
5Dr		Non-sodic duplex soils with red B horizon	5Dra with minor 5Drb	Dalrymple
5Dy		Sodic and non-sodic duplex soils with yellow or grey B horizon	5Dya, 5Dyb with minor 5Dyc and 5Dyd on lower slopes.	Kyanoota, Ranly

Table 1 (continued)

Mapping unit	Landscape unit	Soil group	DPI soil types	Soil Series (a)
6Uc	Landscape unit 6 - Miscellaneous alluvial landforms.	Soils with coarse texture throughout (sand, sandy loam).	6Uca, 6Ucb, 6Ucc	Burdekin
6Um		Soils with medium texture throughout (loam, clay loam).	6Uma, 6Umb	Burdekin
6Uf		Dark and grey non- cracking clays.	6Ufa with minor 6Ufb and 6Ufc	-----
6Gn		Gradational textured soils.	6Gna with minor 6Gne and 6Gnd	Farencer
6Dr		Sodic duplex soils with red B horizon	6Drc	Lanona
6Db		Sodic duplex soils with brown B horizon	6Dba, 6Dbb, 6Dbh with minor 6Dbd and 6Dbe	Kelona, Glenalder, Noto, Embie
6Dy		Sodic duplex soils with grey B horizon	6Dyg, 6Dyj with minor 6Dyh, 6Dye and 6Dyf	Kelona, Lanona, Jucuna
6Dd		Sodic duplex soils with dark B horizon	6Dda	-----

(a) after Hubble and Thompson (1953)

The gently undulating rises of LU5 are located towards the southern boundary of the study area at the footslopes of the ranges and extend towards the ocean between Slater and Wilson Creeks. Small isolated areas surrounded by alluvial deposits are also present. Isolated small areas of undulating rises on weathered granites (LU4) also occur.

The area is well drained by a number of narrow, deeply incised streams, which originate in the ranges in the south, and run approximately parallel, in a direction just east of north towards the ocean. A number of gullies have developed from these creeks and many are still actively eroding.

Soil distribution

Stage I

Between **Yellow Gin** and **Wangaratta Creeks** (Inkerman East Section) the upper slopes are dominated by cracking clays of LU1 and by duplex and gradational soils on the fans and creek levees of LU6. A small area near the southern boundary consists mainly of red non-sodic duplex soils of LU5 (5Dr) on slopes of 2 to 4 percent. The lower area is a treeless, low sloping (<0.5%) plain with grey clays and black earths of LU3. This plain has been colonised by a number of woody weeds, mainly prickly acacia (*Acacia nilotica*) and chinee apple (*Ziziphus mauritiana*).

Erosion is active in this section with gullies extending the tributary of Yellow Gin and Cabbage Tree Creeks. Overbank flow along Yellow Gin and Wangaratta Creeks has created a complex landscape of stream channels, bars and banks.

The main soils in the area between **Wangaratta** and **Slater Creeks** are cracking clays of LU1. Red non-sodic duplex soils (5Dr) occupy the gently sloping areas near the southern boundary. An outcrop of rock is located on the southern boundary (UMA 117).

The area between **Slater** and **Wilson Creeks** is dominated by soils of the gently undulating rises (LU4 and 5) with cracking clays of LU1 in the depressions. The major soils on these rises are red non-sodic duplex soils (5Dr). Some yellow, neutral to alkaline duplex soils have also been identified on mid to lower slopes. Some alkaline, yellow and grey duplex soils (5Dy) on lower slopes with the potential to become salinised have also been mapped (UMA 26 and 29).

On these undulating rises, gullies have developed on the higher slopes which are usually between 2 and 4 percent. These areas were mapped as eroded phases.

On the crests and gently sloping (<1%) upper slopes of these rises, the soils are moderately shallow (<0.6 m) usually with a surface cover of 10 to 20% of pebbles or small rocks. Some small rock outcrops were observed in the area indicating that dykes are present in the area. This is supported by the occurrences of small areas of cracking clays throughout the 5Dr soils, which are indicators of the presence of dykes. A large area of rock outcrop was mapped as a rock phase 5R (UMA 57).

Yellow duplex soils with coarse-textured surfaces, indicating a coarser-grained parent rock of LU4 have been mapped in this area and also just west of **Wilson Creek**. One higher crest with exposed granite tors has been mapped (UMA 63).

Between **Wilson** and **Molongle Creeks** the lower areas are dominated by grey clays of the alluvial plains of LU1. Levees, fans and floodouts of prior and present streams have formed over LU1. The main soils on these slightly higher areas are sodic duplex soils (6Db, 6Dy), gradational soils (6Gn) and uniform non cracking clays (6Uf). D horizons with textures coarser than sandy clay loam, are often present before 1.5 m.

Relict alluvial plains of LU3 are also present in this section. These plains are usually strongly dissected and therefore mapped as eroded phases. The non-eroded Tolgai clays of LU3 have high sodicity and salt levels and have deep gilgais. Boree (*Acacia tephrina*) is a common scrub species on the cracking clays; false sandalwood (*Eremophila mitchellii*) occurs on the strongly sodic duplex soils (3Dy) of this landscape unit.

In this section, some areas of LU5 occur above the proposed channel position with much of the steeper areas being eroded.

Stage II

The landscape composition of Stage II is different from that of Stage I. Landscape unit 3A, with the highly favourable Koberinga soils, is absent from Stage II. The area of landscape unit 3B, with the unattractive Tolgai clays and strongly sodic-duplex soils, is about three times greater. The area of cracking clays of landscape unit 1 is about 2700 ha less than in Stage I with landscape unit 6 occupying about 1000 ha more.

Uniform medium-textured soils (6Um), gradational soils (6Gn) and non-cracking clays (6Uf) occupy the eastern levee of **Molongle Creek** and the northern part of the western levee of the **Elliot River**. These soils as well as sodic duplex soils (6Db, 6Dy) encroach onto the cracking clays of LU1 (1Ug).

The cracking clay plains (LU1) with prior streams of LU6 extend to the **Armstrong Creek** area, and are also found between **Jack Creek** and the **Elliot River** levee. The soils in the channels of the prior streams are either non-sodic duplex soils or coarse-textured soils. Sodic duplex soils occupy the old levees.

The relict alluvial plain of LU3 is widespread throughout Stage II between **Molongle Creek** and the **Elliot River**. The highly erodible cracking clay (3Ug or Tolgai clay) growing boree scrub and the strongly sodic duplex soil (3Dy) with sandalwood were mapped as an eroded (3E) phase. A hardsetting, weakly-gilgaied cracking clay supporting narrow-leaved ironbark (*Eucalyptus drepanophylla*), beefwood (*Grevillea striata*), *Melaleuca* species and false sandalwood is present on this landscape unit. The pH of this soil varies from neutral at the surface to alkaline ($pH > 8.0$) between 0.6 to 0.9 m and then decreases to neutral at depth. Limited chemical analyses on this soil type, 3Ugh (Thompson 1977), show that by 0.6 m the soil is strongly sodic and salt levels are high by 0.9 m.

The remainder of the depositional area has an extremely complex pattern of numerous prior streams with associated levees, fans and floodouts dissecting LU1. Uniform sands (6Uc) are often associated in the former stream channels with solodic soils on the levees. Cracking clays (1Ug) or dark and grey solodic soils (6Dd, 6Dy) are often present in depressions. Depths and textures of A horizons as well as chemical characteristics of the B horizon vary widely over a short distance. Local relief of 1 to 2 metres may also be present. In addition, many small areas of strongly sodic duplex soils growing sandalwood are associated within these areas, increasing the complexity.

Two broad ridges of LU5 occur on the southern boundary. Red, non-sodic, duplex soils as well as neutral yellow duplex soils are the main soils of these areas. However, significant uniform areas of cracking clays (5Ug) have been mapped, as well as a complex of 5Dr and 5Ug soils.

A low ridge of LU5 occurs just west of **Guthalungra** (UMA 288). The crests and upper slopes are occupied by red, non-sodic, duplex soils. Yellow duplex soils occupy small areas on the lower slopes. An outcrop of quartz was observed in the north east of this ridge. A low ridge of cracking clay (5Ug)(UMA 222) with a small area of red, non-sodic duplex soil (5Dr)(UMA 234) was mapped just to the north of the above ridge. Rock outcrop was also observed in the north-eastern side of this UMA.

Other small low ridges of LU5 appear in the area. Again, red duplex soils (5Dr) are common on these ridges, although one such ridge (3 km east of **Molongle Creek** and 2 km south of the Bruce Highway) is occupied by a range of cracking clays including red clays and black earths (UMA 245). Red Bloodwood (*Eucalyptus dichromopholia*) and narrow leaved ironbark are common on this ridge.

A small low ridge just west of Sandy Creek is occupied mainly by neutral yellow duplex soils (5Dy)(UMA 260). **Red Hill**, a much higher ridge with rock exposures is mapped as 5R and is located west of **Armstrong Creek** on the Bruce Highway (UMA 205).

Yellow duplex soils (4Dy) formed *in situ* on a coarse-grained rock are found on a ridge between **Sandy** and **Big Jack Creeks** just south of the Bruce Highway (UMA 285 and 302).

Table 2 tabulates the areas of the soil groups and phases of the landscape units for the two stages of the assessment.

Land suitability

The suitability of the land to grow sugar-cane under furrow irrigation was determined using the land suitability classification currently being used in the BRIA which is described in detail in Donnollan *et al.* (in preparation). Table 3 shows the areas of suitable, marginal, (areas of 5Dr and 5Dy shown separately) and unsuitable lands in Stage I and Stage II. About 50% of the land in Stage I is suitable but this reduces to less than 25% in Stage II. Appendix I gives the area (ha) and sugar-cane suitability for furrow irrigation for each UMA in the study area.

Table 2. Areas of soil groups and phases of the landscape units for Stage I and Stage II of the Burdekin River Right Bank-Yellow Gin Creek to Elliot River, BRIA.

	Landscape unit	Cracking clays Ug	Duplex soils D	Eroded phases	Other soils or soil phases	Total
Stage I	LU1	5939**	470	671	186	7266
	LU3A*	1498	-	72	-	1570
	LU3B+	-	248	1884	-	2132
	LU4	-	348	-	43	391
	LU5	30	1568	1443	46	3087
	LU6	-	2698	2171	1034	5903
SUB-TOTAL		7407	5332	6241	1309	20 349
Stage II	LU1	3240	553	-	-	3793
	LU3B	3054	373	2742	-	6169
	LU4	-	176	10	-	186
	LU5	278	1603	740	36	2657
	LU6	-	4239	1999	757	6995
SUB-TOTAL		6572	6944	5491	793	19 800
	TOTAL	**14 039**	**12 276**	**11 732**	**2 102**	**40 149**

* Low lying plain (west of Wangaratta Creek)
** Hectares.
+ Relict alluvial plain (east of Wangaratta Creek)

Table 3. Areas of suitable, marginal and unsuitable lands for the furrow irrigation of sugar-cane in Stage I and Stage II of the Burdekin River Right Bank-Yellow Gin Creek to Elliot River, BRIA.

Stage	Suitable lands	Marginal lands		Unsuitable lands	Total
		(excluding 5Dr and 5Dy)	(5Dr, 5Dy)		
I	10 026*	1 339	1 420	7 564	20 349
II	5 041	4 310	1 603	8 846	19 800
TOTAL	**15 067**	**5 649**	**3 023**	**16 410**	**40 149**

* Hectares.

The cracking clays (Ug) of LU1, LU3(A) (low lying alluvial plain, west of **Wangaratta Creek**) and LU5 are suitable. Most areas of cracking clays of LU3B (relict alluvial plain) are unsuitable due to excessive salinity or sodicity or are already eroded. There are some areas of 3Ug (UMA 251 and 392), equivalent to 3Ugh as mapped by Thompson (1977), that have been rated as marginal, pending further evaluation. This evaluation, if considered necessary, would require more rigorous soil analyses and perhaps field crop trials. A more detailed evaluation of water tables may also be necessary on this relict alluvial plain.

The suitability of the sodic duplex soils of the alluvial landscape units 1, 3 and 6 is dependant mainly on the level of sodicity at and below 0.3 m. This property is related to field pH. Soils which are strongly sodic (<14 Exchangeable Sodium Percentage ESP, or with pH >8.5 by 0.3 m), are regarded as marginal due to their low infiltration, low plant available water capacity and adverse affects on germination and plant establishment. The presence of plant species such as false sandalwood and beefwood are good indicators of soils with strongly sodic B horizons at 0.3 m.

Areas with soils requiring different management techniques over a short distance (soil complexity) have been classified as marginal. Gradational soils (6Gn), medium-textured soils and fine textured uniform soils (6Um, 6Uf) are regarded as suitable as they are well drained and salt free.

The soil groups of intake areas, such as 5Dr and 5Dy, are regarded as marginal for furrow irrigation of sugar-cane. These soils are highly permeable and losses to groundwater under furrow irrigation are expected to salinise the lower slopes of LU5 and influence a rise in the regional groundwater table. Spray or trickle irrigation are more appropriate on these soils as losses to groundwater will be lower.

Two discharge areas (UMA 26 and 29) are located on the coastal side of the highway between **Arrow** and **Wilson Creeks**. The soil type in these UMAs are 5Dye with a high pH (>8.5) at 0.6 m. These areas support beefwood and have patches of bare areas throughout.

Mapping units of yellow duplex soils of LU4 (4Dy) are either unsuitable or marginal as these areas would act as intake areas. A low ridge east of **Wilson Creek** on the Bruce Highway was classified unsuitable due to the shallow soil (<0.6 m), high pH at 0.3 m and mottling in the subsoil (UMA 60). Tea tree is the dominant vegetation.

All mapping units with rock exposures have been mapped as a rocky phase (R) and are unsuitable. Two areas near the coast between **Wilson** and **Rocky Ponds Creek** have been mapped as a swamp phase (1SP) and unsuitable. Areas mapped as eroded phases (E) are either actively eroding or have been affected by overbank flooding resulting in a locally undulating landscape with depressions and ridges. Small isolated areas within these mapping units may not be degraded, but their size and position in relation to the surrounding unsuitable units limit their suitability for irrigation. Therefore, no attempt has been made to separate these units from the units mapped as eroded phases. All mapping units with eroded phases are unsuitable. The eroded phases occupy about 30 percent of the total area.

Large areas of suitable land, mainly cracking clays of LU1 and LU3 are located between **Yellow Gin** and **Wangaratta Creeks**. Large contiguous areas west of **Rocky Ponds Creek** and east to **R.M. Creek** also exist, but these areas are not as uniform as the areas west of Wangaratta Creek, as some complexity with soils and relief has been created by the prior streams and fans dissecting the cracking clay plain (1Ug). Areas of marginal sodic duplex soils are present in the area between **Gates** and **R.M. Creeks**, making this area less attractive.

Areas on both sides of **Molongle Creek** especially in the northern section of the area are suitable. Much of this land is already being used to grow irrigated horticultural crops.

The only other large suitable contiguous area of land is the cracking clay plain (LU1) on the western side of the **Elliot River** north of the Bruce Highway. However, prior streams dissecting the cracking clay plain, create some complexity in this area.

Small suitable areas are present in other sections of the survey area but some difficulties in designing farms may be experienced especially when these areas adjoin unsuitable degraded areas.

The area extending from **Slater** to **Wilson Creeks** includes the marginal soils of the intake areas as well as many eroded or channelled areas.

The area east of **Armstrong Creek** to **Big Jack Creek** is a very complex area in relation to soils and relief. Most of this area has therefore been regarded as marginal due to the difficulties in effectively furrow irrigating these areas.

About 10 000 ha of land between **Yellow Gin** and **Molongle Creeks** in the BRIA is suitable for furrow irrigation of sugar-cane, with a further 5 000 ha of suitable lands between **Molongle Creek** and the **Elliot River**. This assessment represents the maximum area suitable for the furrow irrigation of crops, as sugar-cane is adaptable to a wider range of soils than most other crops. However, as cracking clays occupy about 70 percent of the suitable lands, the area suitable for furrow irrigation of other field crops would be similar, but would be much less for horticultural crops. The area suitable for flood irrigation of rice would also be much less, as slopes, especially nearer the EMC, are greater than the 0.5 percent recognised as too steep for rice production in ponded bays. Most of the 3 000 ha of red and yellow duplex soils of landscape unit 5 (5Dr, 5Dy), regarded as marginal for furrow irrigation of sugar-cane, as well as the well drained soils of LU6, would be suitable for horticulture and tree production.

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APPENDIX 1.

Areas of suitable - S, marginal - M, and unsuitable - U lands, for the furrow irrigation of sugar-cane for each unique map area (UMA) of the Right Bank - Yellow Gin Creek to Elliot River, Burdekin River Irrigation Area (BRIA).

UMA no.	UMA name	Sugar-cane suitability	Area (ha)	UMA no	UMA name	Sugar-cane suitability	Area (ha)
1	6E	U	646	33	5E	U	1,242
2	3Ug	S	1,316	34	5E	U	30
3	3E	U	72	35	1Ug	S	11
4	3Ug	S	17	36	1Ug	S	50
5	1Ug	S	519	37	5Dy	M	88
6	6E	U	118	38	1Ug-1Dy	S	78
7	4Dy	M	179	39	1Ug	S	30
8	6Uf	M	967	40	1Ug	S	134
9	1E	U	38	41	5Dr	M	443
10	1Ug	S	263	42	1Dy	M	31
11	6E	U	112	43	1Ug	S	6
12	1Ug	S	108	44	1E	U	86
13	1SP	U	39	45	6Db-6Dd	S	95
14	6Gn	S	67	46	1Ug	S	7
15	1Ug	S	64	47	1Ug	S	55
16	1Ug-6Dy	S	91	48	1E	U	120
17	1Dy	U	51	49	1Ug	S	141
18	6E	U	35	50	6Db	S	18
19	6Dy	S	18	51	6Uf	S	38
20	6Gn	S	26	52	5E	U	4
21	1SP	U	147	53	1Ug	S	62
22	6Dy	S	118	54	6Dy	S	13
23	4Dy	M	95	55	1E	U	173
24	1Ug	S	14	56	3E	U	162
25	1Ug	S	31	57	5R	U	17
26	5Dy	U	64	58	6Uf	M	78
27	5E	U	34	59	3Ug	U	23
28	1Ug	S	49	60	4Dy	U	34
29	5Dy	U	22	61	1E	U	63
30	6Db	S	69	62	1Ug	S	41
31	3Ug	U	14	63	4R	U	43
32	5Dr	M	144	64	6Uf	S	142

APPENDIX 1 (continued).

UMA no.	UMA name	Sugar-cane suitability	Area (ha)	UMA no.	UMA name	Sugar-cane suitability	Area (ha)
65	6E	U	493	100	6Gn	S	18
66	6E	U	158	101	5Dy	M	21
67	5Dr	M	43	102	6Uf	S	49
68	6Gn-1Ug	S	69	103	6Gn	S	22
69	1Ug-6Dy	U	343	104	1Ug	S	16
70	1Ug	S	29	106	6Um-6Uf	S	96
71	6E	U	484	107	1E	U	40
72	1Ug	S	18	108	6Gn-6Uf	S	187
73	6Db-6Uf	S	643	109	6E	U	21
74	6E	U	35	110	6Dy	U	38
75	5E	U	18	111	6Gn-1Ug	S	23
76	5Dy	M	36	112	1Ug	S	26
77	5Dr	M	13	113	1Dy	M	18
78	1Ug	S	162	114	6Uf	S	39
79	5Dy	U	19	115	6Dy-6Db	S	287
80	6Db	S	43	116	1Ug	S	23
81	6Db	S	151	117	5R	U	29
82	6Db	S	102	118	1E	U	135
83	5Dr	M	192	119	1Ug	S	86
84	5Dr	M	4	120	1Ug	S	31
85	1Ug	S	328	121	1Ug	S	286
86	6Dy-6Uf	S	300	122	1Ug	S	11
87	5Dr	M	124	123	6E	U	626
88	5Dy	U	7	124	5Dr	M	44
89	5Ug	S	21	125	5Dr	M	53
90	5Dr	M	52	126	1Ug	S	376
91	1Dy	U	15	127	6Dy	U	21
92	1Ug	S	70	128	1Ug	S	18
93	1Ug	S	170	129	1Dy	M	26
94	1Ug	S	24	130	6Db-6Uf	S	126
95	1Ug	S	42	131	1Dy	M	11
96	5E	U	27	132	1Ug	S	45
97	1Ug	S	39	133	6Dy	M	417
98	1Ug	S	224	134	1Ug	S	853
99	1Ug-1Dy	S	66	135	5Dr	M	10

APPENDIX 1 (continued).

UMA no.	UMA name	Sugar-cane suitability	Area (ha)	UMA no.	UMA name	Sugar-cane suitability	Area (ha)
136	6Dy-1Ug	M	159	171	3Ug	U	8
137	1Ug	S	27	172	6Dy	M	50
138	1Dy	M	29	173	6Db	S	56
139	1Dy	M	32	174	6E	U	644
140	6E	U	6	175	1Dy	M	13
141	1Ug	S	258	176	1Ug	S	63
142	6Uf	S	50	177	1Dy-1Ug	M	26
143	1Ug	S	137	178	5Dr	M	29
144	6Db	S	6	179	1Ug	S	2
145	1Ug	S	23	180	1Ug	S	23
146	1Ug	S	15	181	1Ug	S	76
147	3Dy	U	27	182	3Dy	U	16
148	1Db	M	38	183	4Dy	U	20
149	1Ug	S	30	184	1Ug	S	236
150	6Db	S	62	185	1Dy-1Ug	M	102
151	1Ug	S	722	186	6Dd	S	17
152	6Dy-1Ug	M	202	187	6Dy	M	87
153	6Uf	S	179	188	3Dy-3Ug	U	40
154	6Uf	S	18	189	6Db-6Uc	M	88
155	5Dr	M	21	190	1Dy-1Ug	M	36
156	6E	U	416	191	6Dy-1Ug	M	204
157	3E	U	287	192	6SP	M	17
158	6Db	S	64	193	6Db	M	36
159	1Ug	U	43	194	4Dy	U	19
160	6Dy-6Db	M	269	195	1Ug	S	13
161	3Dy	U	157	196	3Ug	U	7
162	1Dy	M	136	197	3Dy	U	143
163	6E	U	132	198	6Dy	U	9
164	1Dy-1Ug	M	22	199	6Dy	M	26
165	3Ug	U	837	200	3Ug	U	171
166	1Ug-1Dy	M	64	201	6Dy	U	22
167	6Gn	S	25	202	3Dy-3Ug	U	131
168	1Ug	S	13	203	5Dr	M	5
169	3E	U	140	204	6Dy-6Db	M	313
170	3E	U	933	205	5R	U	36

APPENDIX 1 (continued)

UMA no.	UMA name	Sugar-cane suitability	Area (ha)	UMA no.	UMA name	Sugar-cane suitability	Area (ha)
206	6Dy	S	199	241	5Dr	M	23
207	6Dy	S	10	242	6Dy	M	133
208	6Uf-1Ug	S	104	243	1Ug	S	156
209	6Dy	M	58	244	3Ug	U	17
210	6Db	S	17	245	5Ug	S	47
211	3E	U	28	246	1Ug	S	52
212	1Ug	S	303	247	6Uc	U	38
213	6Uf-6Um	S	77	248	3Dy	U	18
214	6Dy	M	15	249	6E	U	43
215	6E	U	13	250	6Uf	S	13
216	6Gn	S	38	251	3Ug	M	888
217	1E	U	16	252	6E	U	54
218	3E	U	761	253	6Dd	S	33
219	6Db	S	19	254	6Dy	M	7
220	6Dy-6Uf	M	42	255	6Dy	U	5
221	3Ug	U	14	256	6Dy	U	22
222	5Ug	S	69	257	6Uf	S	8
223	1Ug	S	23	258	6Uf	S	18
224	3Dy	U	47	259	3Ug	U	15
225	1Dy-6Dy	M	265	260	6Dy	M	11
226	1Ug-6Db	S	26	261	6Db-6Dy	M	113
227	6Dy	S	90	262	1Ug-6Dy	M	31
228	5Dr	M	28	263	6Dy	U	74
229	3Ug	U	18	264	6Db-6Uc	M	118
230	1Ug-1Dy	S	167	265	6Dy	U	9
231	6Dy	M	14	266	6Dy	U	26
232	5E	U	89	267	6Dy	M	12
233	1Dy	M	46	268	1Ug	S	13
234	5Dr	M	12	269	3E	U	152
235	6Dy	S	118	270	6Dy	M	26
236	6Db-6Dy	S	54	271	6Dy	M	9
237	6Dy	U	17	272	6Dy	M	78
238	1Ug	S	160	273	6Dy	U	13
239	1Ug-1Dy	M	95	274	3Ug	U	14
240	1Ug	S	30	275	6Uf	S	69

APPENDIX 1 (continued).

UMA no.	UMA name	Sugar-cane suitability	Area (ha)	UMA no.	UMA name	Sugar-cane suitability	Area (ha)
276	6Dy-1Ug	M	70	311	1Ug	S	268
277	5Ug	S	10	312	6Dy	M	37
278	3Ug	U	4	313	6E	U	34
279	1Ug	S	249	314	6Dy	U	98
280	6Db	S	96	315	6Dy	M	39
281	6Uf	S	11	316	5Dy	U	20
282	6Dr	S	13	317	1Ug	S	6
283	1Ug	S	14	318	1Ug	S	17
284	6Dd	S	18	319	3E	U	99
285	4Dy	U	44	320	6Db	U	27
286	5Ug	S	45	321	6Um	S	33
287	6Uf	S	12	322	6Db	U	21
288	5Dr	M	268	323	6Dy-6Uc	U	32
289	5Dr	M	34	324	6Dy	U	15
290	6Dy	U	3	325	1Dy-1Ug	M	19
291	3Ug	U	234	326	1Ug	S	84
292	6Dy	M	5	327	3E	U	1,240
293	6Um	S	37	328	6Db	S	217
294	1Ug	S	5	329	3Ug	U	19
295	3Ug	U	37	330	6Dy	M	174
296	6Db	S	83	331	6Dy	M	26
297	1Ug	S	9	332	1Ug	S	94
298	4E	U	10	333	1Dy	M	16
299	6Dy	U	9	334	3Ug-3Dy	U	40
300	3Ug	U	12	335	3E	U	418
301	5Dy	U	16	336	6Uf	S	39
302	4Dy	U	133	337	5Dy	M	10
303	5E	U	28	338	6Dy	U	5
304	6Dy	U	87	339	6Db-1Ug	M	16
305	3Ug	U	18	340	6E	U	17
306	6Uf	S	57	341	6Dy	M	45
307	1Ug	M	14	342	5Dr	M	160
308	5Dr-5Dy	M	56	343	1Dy	U	6
309	6Dy	U	6	344	3Ug	U	183
310	5Dr	M	121	345	6Dy	M	22

APPENDIX 1 (continued).

UMA no.	UMA name	Sugar-cane suitability	Area (ha)	UMA no.	UMA name	Sugar-cane suitability	Area (ha)
346	1Ug	S	47	378	5E	U	175
347	3Ug	U	174	379	3Ug	U	26
348	3Ug	U	14	380	6Db	M	21
349	6Dy	U	47	381	5Dr-5Ug	M	134
350	6Dy-1Ug	M	75	382	5Dr	M	82
351	1Ug	S	30	383	5E	U	204
352	6Dy	U	15	384	3Ug	U	35
353	6Dy	U	22	386	5E	U	141
354	3Ug-3Dy	U	37	387	1Ug	S	14
355	1Ug	S	121	388	3Dy	U	9
356	3Dy	U	4	389	3E	U	108
357	3E	U	188	390	5Dr	M	260
358	1Ug	S	13	391	1Ug	S	21
359	5Ug	S	48	392	3Ug	M	45
360	5Dr-5Dy	M	448	393	5Dr	M	36
361	1Ug	S	238	394	1Dy-6Dy	M	87
362	5E	U	34	395	3Ug	U	138
363	3Ug	U	7	396	3Ug	M	85
364	3Dy	U	5	397	3E	U	99
365	5E	U	103	398	3Ug	U	27
366	5Ug	S	62	399	3Dy	U	10
367	6Dy	U	6	400	3Ug	U	49
368	6Dy	U	6	401	3Dy	U	13
369	3Ug	U	9	402	5Dr	M	22
370	6Dy	S	17	403	5Dr	M	11
371	5Ug	S	6	404	3E	U	11
372	6Db	S	105	405	3Ug	M	3
373	1Ug	S	5	406	5Dr	M	7
374	5E	U	55	407	6E	U	84
375	6Dy	U	12	TOTAL			40 149
376	5Dy	M	55				
377	5Dr	M	8				