Chapter **6**

Queensland Agricultural Land Audit

Far North Queensland

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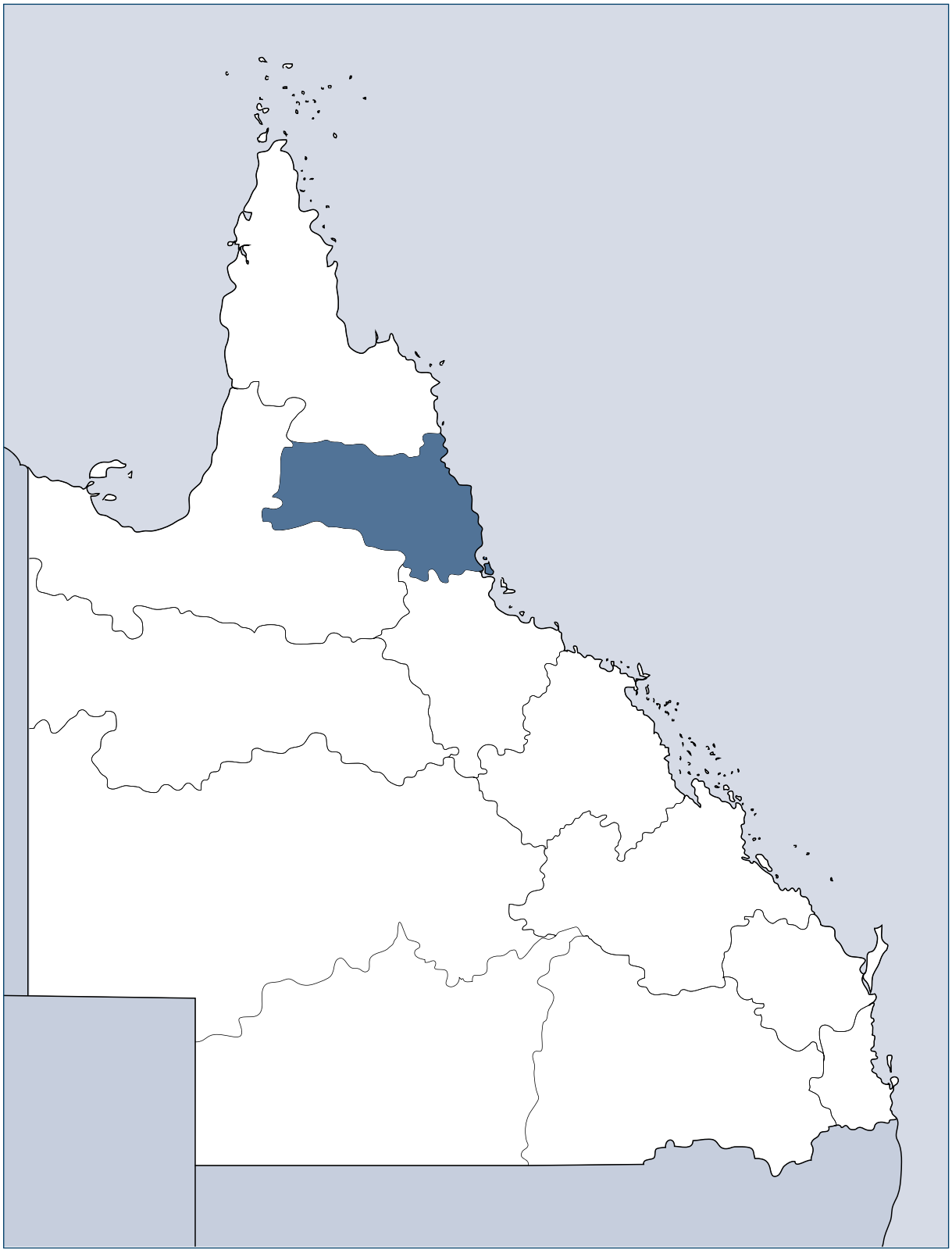

6.1.1 Economic profile

The Far North Queensland region comprises the five local government areas of Cairns Regional Council, Cassowary Coast Regional Council, Tablelands Regional Council, Wujal Wujal Aboriginal Shire Council and Yarrabah Aboriginal Shire Council. It has a total area of approximately 73 276 km^2, or 4.3 per cent of the total area of the state (see Map 6.1).

The main industries developed in the region in the past 150 years were gold and tin mining, timber-getting and sugarcane production. Currently agricultural production in Far North Queensland is worth $797.1 million to the state's economy.[1] This is predominantly fruit production, which is valued at $370.2 million. Broadacre cropping is also a strong industry, contributing $216.3 million (including sugarcane at $196.6 million).

The region's natural areas are characterised by their high biodiversity, agricultural and fisheries productivity and scenic attraction. Agriculture, forestry and fisheries industries (predominantly horticulture, sugarcane, dairying and grazing) are major contributors to the regional economy.[2]

The north coast contains significant areas of agricultural land and areas of high ecological significance, including large areas of the Daintree and other Wet Tropics World Heritage rainforest. The total Wet Tropics World Heritage Area is approximately 740 000 hectares and includes areas of agricultural land use as well as areas of nature conservation (see Section 6.1.6).

The Cairns local government area includes significant areas of national park and state forest, rural areas and growing urban areas. Rural land throughout this area is used predominantly for sugarcane farming. For example, Gordonvale is a small sugarcane town south of Cairns and provides sugarcane for the Mulgrave mill. Also, this area has important agricultural infrastructure and supply-chain components including a major port for exporting raw sugar, live cattle, mining products and agricultural products.[3]

The Tablelands local government area is favourable for agricultural land uses. The town of Mareeba has considerable future growth potential and plays a pivotal role in servicing agriculture and mining. The town of Atherton has an important rural industry function and is within one of the richest and most diverse agricultural areas in the state. Because of its favourable climate, good soils and ample water, the Atherton Tableland is a significant agricultural region.[2] It is widely regarded as one of Queensland's most valuable agricultural areas. Rural land is currently used for cropping, horticulture, grazing and dairying. There has been a growing trend towards diversifying farm income through food-based tourism. Several mines currently operate in the area, although mining tends to be small- to medium-scale (due to the generally small size of deposits) and is decreasing.

The Cassowary Coast local government area is well known as the nation's banana growing hub. Its banana industry is worth $400 million and its sugarcane industry has driven growth in the region since the late 1800s. These industries have different production requirements so have developed side by side without competition for land resources over this time. While sugarcane and bananas have traditionally been dominant industries in the region, there is an increasing diversity in crops. Produce includes pawpaws, tea, rambutans, pineapples, watermelons, pumpkins, lettuces, lychees, mangosteens and even less traditional crops for the region such as tomatoes and vanilla. Cattle, timber, aquaculture and fruit wineries also feature among the agriculture-based industries.

The Cassowary Coast local government area contributes 66 per cent of the state's production of fruit. The area's contribution, valued at $243.7 million, comprises mainly plantation fruit such as bananas and pawpaws, which have a commodity value of $242.1 million. Sugarcane for this area is valued at $101.2 million (51 per cent of the state's commodity value).

1 Australian Bureau of Statistics 2012, Value of agricultural commodities produced, Australia, 2010–11, cat. no. 7503.0, Australian Bureau of Statistics, Canberra.

2 Department of Infrastructure and Planning 2009, *Far North Queensland regional plan 2009–2031*, State of Queensland.

3 Cairns Regional Council 2012, About city—background and history, economy.id, viewed 8 January 2013, ‹http://economy.id.com.au/default.aspx?id=363&pg=12110›.

The Tablelands local government area also contributes significantly to sugarcane (13 per cent) and fruit production (29 per cent) for the region. (See Section 6.2 for more information on values of different industries.)

The estimated resident population of Far North Queensland (as at June 2011) was 252 233 people, or 5.5 per cent of the state's population. This is expected to grow over the next 20 years by an average of 1.5 per cent per year. The increase is largely due to net migration, including people recently retired or seeking a lifestyle change, with natural increases remaining relatively steady. In comparison, Queensland is expected to have an average annual growth rate of 1.8 per cent over the same period. The *Far North Queensland regional plan 2009–2031* has identified that the majority of the region's growth will be accommodated in a corridor south of Cairns including the Mount Peter area.

For the June quarter of 2012, the region had an unemployment rate of 8.1 per cent, higher than the Queensland rate of 5.5 per cent.[4]

At June 2011, 5.2 per cent of the workforce was employed in the agriculture, forestry and fishing industries; for the state, this was 2.7 per cent. Agriculture, forestry and fisheries businesses represent 16.5 per cent of businesses registered in the region; for the state, this was 11.1 per cent.

Land valuations in the region have not varied significantly in the past 10 years compared to other regions of the state. Grazing land across the region has seen a 60 per cent increase from $5000 per hectare in 2001 to $8000 in 2012. Sugarcane land in the Cairns Regional Council area has increased by 70 per cent (from $10 000 to $17 000 per hectare), whereas sugarcane land in the Cassowary Coast Regional Council area has remained unchanged at $8000 per hectare. The biggest increase was seen in the Tablelands Regional Council area, where arable land increased by 90 per cent from $6000 to $11 500 per hectare and forest grazing by 167 per cent (from a very low base).[5]

Table 6.1 The change in land values for the Far North Queensland region

Local authority	Land type	Market valuation ($/ha)			Percentage change 2001–12	State market valuations range 2012 ($/ha)
		Pre-boom 2001	Boom (market peak) 2007	Post-boom 2012		
Cairns Regional Council	Grazing	5 000	9 000	8 000	+60	20 to 25 000
	Cane (dryland)	10 000	18 000	17 000	+70	7 100 to 17 000
	Aquaculture	50 000	50 000	50 000	0	7 000 to 50 000
Cassowary Coast Regional Council	Grazing	5 000	9 000	8 000	+60	20 to 25 000
	Cane (dryland)	8 000	11 250	8 000	0	7 100 to 17 000
Tablelands Regional Council	Forest grazing	9	30	24	+167	24 to 1 500
	Arable	6 000	10 000	11 500	+92	1 150 to 45 000
Wujal Wujal Aboriginal Shire Council*	—	—	—	—	—	—
Yarrabah Aboriginal Shire Council*	—	—	—	—	—	—

Source: Data provided by the Department of Natural Resources and Mines, State Valuation Service, July 2012

* Deed of grant in trust (DOGIT) communities where there is no active or liquid market from which a market value could be derived.

4 Australian Bureau of Statistics 2012, dataset from Queensland regional profiles (generated 10 December 2012), Office of Economic and Statistical Research, Queensland Treasury and Trade.

5 State Valuation Service 2012, 'Statewide land valuation (market value) report', Department of Natural Resources and Mines, Queensland.

6.1.2 Strengths, weaknesses, opportunities and threats

Key regional issues

- There are a number of biosecurity threats due to importation risks from Asia and the Torres Strait Islands.
- While water supplies are mostly allocated, a large proportion of the available water is underused.
- Large areas (approximately 110 000 hectares) of suitable land are available in the upper Herbert catchment and good dam sites are available. However, these areas need more detailed analysis (e.g. of soil and water).
- The international airport in Cairns facilitates export and domestic transport of produce.
- Road transport costs are increasing with rising fuel prices and there is no timely, reliable rail alternative for the supply of fresh produce to southern markets.
- Early harvest (due to climate) creates opportunities to supply produce to southern markets at peak prices.
- The stable local population provides long-term and seasonal staffing. Cairns is a popular tourist destination and attracts backpackers, who help meet transient labour needs.
- Extreme climate events (such as cyclones, storms and flooding) can devastate horticulture, especially in the coastal lowlands.
- Energy security and reliability are low. The region relies completely on baseload power from Central Queensland.

Strengths

The strengths of the region include the following:

- A wide variation (over a relatively short distance) of climates and soils can support a range of niche crops not grown elsewhere in Queensland. Early harvest (due to climate) creates opportunities to supply produce to southern markets at peak prices.
- Reliable rainfall on the coast during and after the wet season reduces the cost of growing bananas and sugarcane. This also means there is less reliance on external water sources for crops, particularly sugarcane and pastures (for the grazing industry).
- The region has some areas of extremely good soils, favourable climate and high rainfall. Combined, these factors create significant potential for diverse production in the region.
- Five sugar mills support the extensive sugarcane industry and also contribute to regional electricity supply.
- There is established transport infrastructure with seaports in Cairns and Mourilyan and an international airport in Cairns, which facilitates export of produce to domestic and international markets.
- Tinaroo Falls Dam and the Mareeba Dimbulah Water Supply Scheme provide irrigation water to approximately 25 000 hectares of irrigated agriculture. The total area with suitable soils for agriculture within and around the Mareeba Dimbulah Water Supply Scheme area is approximately 43 600 hectares. Approximately 33 000 hectares have soils suitable for intensive cropping; of this, 22 000 hectares are suited to irrigated cropping. Water is tradeable and generally available at a reasonable price.
- The major population centres in Cairns, Mossman, Atherton, Innisfail, Mareeba, Malanda and Tully have established rural service providers and related industry.
- There is a major saleyard at Mareeba as well as small-scale abattoirs throughout the region. Of the 30 000 head turn-off in the region, 10 000 are processed locally.
- Far North Queensland offers one of the world's best research and development opportunities for tropical agriculture. Government and university-based facilities are used for high-level scientific research and development projects. The variety of climate, topography and soil in the region creates a wide range of research and development opportunities.
- As baseload power generation is located outside of the region, hydropower provides continuity of electricity supply and supplements at peak demand times.

Weaknesses

The weaknesses of the region include the following:

- The long distance from markets has made road transport one of the largest costs of production. This is likely to increase further as fuel prices rise.
- Despite the existing transport infrastructure into and out of the region, there is heavy reliance on trucks and the Bruce Highway corridor through the wet coastal lowlands. This is often closed during the wet season due to damage from flooding or other extreme weather. Completing bitumen on the inland road is warranted to facilitate improved alternative access routes during wet weather.
- Rail transport is generally unsuitable for the transport of perishable goods to southern markets. It is slow and unreliable and is primarily used for heavy, bulky and non-perishable goods. In most cases, the only suitable and practical option for growers is increasingly expensive road freight. Increasing efficiency around handling times at rail heads, improving rail speed and reducing vibration would help this situation.
- The region faces high biosecurity threats due to its location. Quarantine zones are in place in Cape York to help mitigate the introduction of weeds, diseases and pests. Extensive weed problems (including several Weeds of National Significance) throughout the region impact agricultural production. Animal pests such as feral pigs pose a considerable risk to agricultural production.
- Year-round water supplies can be unreliable outside of the Mareeba Dimbulah Water Supply Scheme area and particularly west of the ranges. Current supplies from Tinaroo Falls Dam are fully allocated and opportunities for the expansion of existing irrigation or the development of new irrigation areas are limited. Most of the region is dry tropics, where annual evaporation is at least twice the annual rainfall.
- Baseload power is sourced from Central Queensland and can be significantly interrupted by extreme weather. There is very limited regional generation of power (from sugar mills and hydropower).
- Mining competes for employment, contractor access and service delivery, reducing the availability of semi-skilled workers. While the region attracts potential workers, there is significant reliance on the transient backpacker and tourist labour pools.
- Current vegetation management restrictions on clearing apply to 94.1 per cent of the region—see Section 6.1.6 ('Vegetation').

Opportunities

The opportunities for expanded agricultural production in the region include the following:

- Expand sugarcane and other crops in the upper Herbert catchment. Large areas of potential have been identified, including 206 908 hectares of A class land. Water-storage facilities would need to be constructed for a new irrigation district. Possible sites for dams that would be able to service an irrigation district of this scale have been identified at the confluence of the Herbert River and the Millstream River. Further detailed soil and water studies would need to be undertaken before expansion.
- Secure regional electricity supplies through additional energy generation. The proposed Mount Emerald wind farm would provide higher electrical reliability for growers in the Atherton Tableland and reduce the effects of transmission losses from the current southern supply. Other areas with high wind reserves include Forsayth and Archer Point (north of the Far North Queensland region). Coal reserves are available at Mount Mulligan and these could feed a baseload power station. The drier areas (dry tropics with on average 300 or more sunny days per year) are also favourable for solar power generation. Solar power could offset electricity costs of running pumping and other on-farm equipment.
- Promote agricultural and food-based tourism, focusing on the local natural environment as well as the highly diverse and unique tropical agriculture and produce.
- Expand the rice industry. Crop trials in the region are producing promising results.[6]
- Introduce chia as a seed crop. It is currently grown in the Ord area and is attracting premium prices. Parts of the Mareeba Dimbulah Water Supply Scheme area have been identified as suitable for chia.

6 Beilharz, N 2012, 'Australia's wild rice may help feed the world', ABC Radio, ‹http://www.abc.net.au/rural/news/content/201207/s3557036.htm›.

- Take up the opportunities for value-adding (e.g. canning, processing, dehydrating) created by the wide range of crops and overlapping harvest periods.
- Develop a new multi-modal transport hub at Innisfail–Mourilyan. This has been identified in regional plans but not progressed to date. It would improve handling and transport efficiencies by rail.
- Increase forestry production from existing grazing country, through managing for both timber (by thinning and harvesting trees) and grazing, creating silvopastoral systems.

Threats

The threats to agricultural production in the region include the following:

- Natural disasters—including bushfires (particularly on the Atherton Tableland), flooding and cyclones (especially on coast)—impact on industry, farm management, infrastructure development, plantation forestry, crop development and transport and telecommunications costs.
- There is competition for water and land from urban growth, industrial development and tourism. Good-quality agricultural land could also be lost to rural residential and lifestyle farming development. Subdivision and fragmentation of agricultural land for other uses is a threat in the major farming areas.
- There are ongoing biosecurity threats due to the proximity of the region to nearby neighbours and trade routes.
- Poor soil management and land degradation can reduce agricultural productivity. Saline groundwater occurs in parts of the Mareeba Dimbulah Water Supply Scheme area and most of the soils are highly prone to erosion.

6.1.3 Climate

The region has an average daily temperature range of 18.3–30.2 °C and on average receives 1998 mm of rainfall each year.[7] Wet season rainfall across the region averages 1393 mm and dry season rainfall averages 610 mm.

However, the climate of the Far North Queensland region is comprised of three distinct regions: coastal, inland and tableland. These represent distinct agro-ecological types comprising different landforms, soils and topography as well as climate.

The coastal climate is a result of elevated terrain aligned north–south, and prevailing easterly trade winds, which result in the highest rainfall in Australia. The average rainfall along the Wet Tropical Coast (including the adjacent mountain ranges) between Daintree and Cardwell is 2041 mm in the wet season and 993 mm in the dry season (based on observations from Tully, Innisfail, Cairns and Mossman). The average local annual rainfall varies from 4127 mm in Tully to 2033 mm in Cairns. Typically, over 60 per cent of the yearly rainfall occurs between December and March. Rainfall intensity can also be extremely high; agriculture on sloping land needs to be carefully managed to avoid erosion.

The inland climate is typical of the savanna environments of northern Australia. It is characterised by a hot (30–35 °C), humid, monsoonal wet season from December to April, during which most of the annual rainfall occurs and tropical cyclones sometimes develop. The wet season average rainfall for the western inland area (based on observations from Abingdon Station and Chillagoe) is 805 mm. The extended dry season, from April to November, is characterised by south-easterly trade winds that bring cooler temperatures but little rain (averaging 75 mm).

The tablelands area has an average wet season rainfall of 1157 mm and an average dry season rainfall of 534 mm. However, the climate of this area is highly variable. The Atherton–Evelyn tablelands have average annual rainfall ranging from 4376 mm at Topaz to 1295 mm at both Kairi and Tinaroo Falls Dam. The drier Mareeba Dimbulah Water Supply Scheme area ranges from 1032 mm at Walkamin to 780 mm at Dimbulah.

7 Average monthly rainfall figures from Bureau of Meteorology data based on nine locations throughout the region: coastal areas (Tully Sugar Mill, Innisfail, Cairns Airport, Mossman Central Mill), tablelands (Upper Barron, Kairi Research Station, Walkamin Research Station) and western inland areas (Abingdon Station and Chillagoe).

Cyclones bring strong winds, intense rainfall and ocean effects such as extreme waves. This hazard is greatest between January and March, but tropical cyclones can occur any time from November to April. On average, 4.7 tropical cyclones per year affect the Queensland Tropical Cyclone Warning Centre Area of Responsibility. This area includes all of Queensland, plus a large portion of the Gulf of Carpentaria and northern New South Wales and extends out to 600 km off the Queensland coast.[8] The Far North Queensland region has been subject to significant cyclones (Oswald, Yasi and Larry) in recent years. Cyclones affect agricultural industries more frequently in this region than in the remainder of the Queensland Tropical Cyclone Warning Centre Area of Responsibility.

In the coastal and tableland areas, local Indigenous communities identify up to five seasons. For example, the five seasons identified by the Kuku-Yalanji people in the Wujal Wujal area are:

- *kambar* or 'proper wet time', the heaviest rainfall period (late December – March)
- *kabakabada* or 'winter rain time', with occasional late rain (April–May)
- *buluriji* or 'cold time', with drier weather and colder nights (June–September)
- *wungariji* or 'hot time', the height of the dry season (October – early November)
- *jarramali* or 'storm time', with thunderstorms and a build-up of rainfall (late November – mid December).[9]

In the future, Far North Queensland is likely to experience more-intense tropical cyclones. Climate trends[10] are for higher temperatures and more extremely hot days. An increase in the 1-in-100-year storm tide event (by 37 cm in Cairns) is forecast. These conditions are likely to lead to increased water demand and irrigation requirements (due to high evapo-transpiration), heat stress in crops, increased drought severity and changes to the agricultural growing season.

6.1.4 Water resources

Objectives for water allocation security are established for rural, urban and industrial supplies in a catchment as part of a water resource plan. This is managed primarily through the Barron water resource plan in the coastal and tableland areas and the Mitchell water resource plan in the inland areas. A water resource plan for the Wet Tropics is currently being produced and this will manage water over the remaining eastern coastal zone (see Map 6.2).

Compared with other areas in Queensland, Far North Queensland has an extremely high rainfall variation (840 mm) between the dry and wet seasons. In some cases, this high annual rainfall creates the perception that water planning is not a critical issue. This is not the case, however, with some of the current water supply infrastructure in the region being fully committed.

Growth in the mining, tourism and agriculture sectors, alongside continued population growth, will drive the need for further water supply infrastructure in the region over the next 20 years. Timing for future water supply infrastructure in the Cairns and Tablelands local government areas will be determined by growth in population and industry, and the impact of climate variability on future supplies. In the remote areas, drivers of demand for new water infrastructure are primarily related to growth in the resources industry and the need to ensure an appropriate level of service to remote communities.[11]

The region is best discussed in three sections: the coastal areas, the tablelands and inland (west of the tablelands). These areas have different and distinct water-management issues. Variable and strongly seasonal rainfall combined with limited catchment storage opportunity may lead to regular periods of insufficient water supply in areas away from the coast.

8 Queensland Government 2009, *Climate change in the Far North Queensland region*, Queensland Government.

9 FNQ NRM Ltd & Rainforest CRC 2005, *Sustaining the Wet Tropics: a regional plan for natural resource management 2004–2008*, FNQ NRM Ltd, Innisfail.

10 CSIRO 2007, *Climate change in Australia: technical report 2007*, CSIRO & Bureau of Meteorology, Melbourne.

11 Department of Local Government and Planning 2011, *Queensland infrastructure plan—building tomorrow's Queensland*, State of Queensland, ‹http://www.dsdip.qld.gov.au/resources/plan/qip/qip-far-north-queensland.pdf›.

In the coastal and tableland areas, irrigation water is required to support agriculture (irrigated agriculture, aquaculture and dairy). Current annual entitlements for irrigation purposes total approximately 230 000 ML. These include unsupplemented water licences from groundwater sources, private dams and natural streams and supplemented water, primarily from Tinaroo Falls Dam in the Mareeba Dimbulah Water Supply Scheme. This scheme is managed under the Barron water resource plan (see Map 6.2).

Salinity hazard areas exists in the Arriga area of the tablelands. This is a small part of the Mareeba Dimbulah Water Supply Scheme, about halfway between Mareeba and Mutchilba. Irrigated sugarcane is the predominant crop in the area. Currently between 700 and 1000 hectares is at high to extreme risk from rising and highly saline groundwater. Almost double that is at moderate risk. A small portion of land has already been taken out of production. Considerable work has been undertaken to study and monitor the problem.

River frontages in the inland area are valuable for the grazing industry as they have higher soil nutrient levels and are a major water resource, particularly in areas where the availability of groundwater is low.

High evapo-transpiration rates across the inland area mean that most crops require much higher irrigation application here than in the coastal area. The coastal area receives sufficient rainfall for most tropical crops and only limited irrigation is required.

Far North Queensland has an extensive river system, which is subject to flooding during the wet season. General heavy rainfall can develop from monsoonal and cyclonic influences, and can result in widespread flooding across the region. Low-lying areas are often affected, with large areas of agriculture and residential areas being inundated with floodwater.

Severe flooding of all the coastal rivers is often associated with tropical cyclones. In most of the catchments, the highest historical flood levels are associated with tropical cyclones, which are isolated events and bias the hydrographs and annual rainfall values in the region.

Water allocations from the Mareeba Dimbulah Water Supply Scheme in the tableland area represent almost 70 per cent of the region's irrigation water entitlements. An existing challenge for farmers is obtaining access to entitlements that are suited to the crop types grown. This can be extremely important for crops requiring significant volumes of water for establishment (such as fruit trees) but less so for more traditional annual crops (such as vegetables).[12]

Various supply sources within the eastern areas of the region are approaching committed or are already fully committed, with varying levels of use. Of particular note is the Barron catchment, where the Barron River's supplemented and unsupplemented flows are fully allocated, as are the Atherton Basalt area A and area B aquifers. This means future water demands cannot be met from these sources without developing further water storage or implementing significant water trading to the highest beneficial use.

In the inland areas, most of the rivers are managed within the Mitchell water resource plan. The eastern boundary of the plan is the Great Dividing Range and there are seasonal water assignment areas in the upper Mitchell River catchment under the plan.

In the coastal areas of the region, groundwater within the Cairns Northern Beaches Subartesian Area is under review as part of the Barron water resource plan review process.

In the inland area of the region, the Chillagoe Groundwater Management Area is managed under the Mitchell water resource plan. All groundwater users within this area have had to give notification of existing works. Progress continues towards issuing licences to water users who have notified the Department of Natural Resources and Mines of their existing works within the Chillagoe Groundwater Management Area. Groundwater from the Bulimba Formation in this area is obtained from palaeochannels, which may be difficult to locate and access. Groundwater quality is poor in water from some formations.

12 Department of Environment and Resource Management 2010, *Far North Queensland regional water supply strategy*, State of Queensland.

Overland flow interference restrictions are in place under the Mitchell and Gulf water resource plans. Restrictions on taking overland flow in these water resource plan areas do not apply when associated works take water for an environmentally relevant activity under the *Environmental Protection Act 1994*, when works are less than 250 ML, when water is contaminated agricultural run-off water, or when a licence is held.

There is currently no permanent water trading in the Mitchell water resource plan area. General reserve surface water is available in the Mitchell River, Lake Mitchell and tributaries under the Mitchell water resource plan. Water licences in the upper Mitchell may be seasonally assigned within zones.

Indigenous reserves are available under the water resource plans for use by traditional owners to establish and develop enterprises that promote economic growth within the community.

In the tablelands, an existing surface water supply scheme offers water trading opportunities within the Mareeba Dimbulah Water Supply Scheme. The scheme entitlement from Lake Tinaroo is managed by SunWater. All unsupplemented surface water and groundwater within the Barron River Basin is controlled by the Barron water resource plan and the Barron resource operations plan. Within the Barron water resource plan area, water allocations are associated with management zones and in some zones may be traded.

In the coastal areas, the Daintree, Mossman, Mulgrave, Russell, Johnstone, Tully, Murray and Herbert River basins have been under the Wet Tropics moratorium since 2010. No additional surface water or groundwater allocation is permitted until the moratorium is removed. The Wet Tropics water resource plan is currently under development and expected to be finalised by the end of 2013.

In the inland areas, general reserve groundwater is available in the Gulf Groundwater Management Area under the Great Artesian Basin resource operations plan. This includes some of the Far North Queensland land audit area. Under this plan, no additional groundwater is available from the Gulf East Groundwater Management Area. All unallocated water within the Staaten River catchment area under the Gulf water resource plan is strategic or Indigenous reserve.

6.1.5 Infrastructure

Resource and agriculture industries need an efficient and reliable freight network that connects to markets and transportation hubs. Connectivity and links to markets and export facilities by road, rail and air is integral to continued growth of these industries. Currently the majority of agricultural produce is transported via road freight to southern markets. Processed sugar is transported by road from all mills in the region to either Mourilyan Harbour or Cairns Harbour for international or domestic export, or to other mills for further processing (see Map 6.3).

Because of its distance from markets, the Far North Queensland region is vulnerable to rising fuel prices. There is a heavy reliance on air and vehicle-based transport over great distances for the import and export of goods and services.

The provision of transport infrastructure from remote communities of the north and west of the region to the densely populated plains of Cairns presents a range of challenges. The steep escarpment between the Atherton Tableland and the coastal plains, combined with Wet Tropics World Heritage restrictions, makes large-scale improvements to transport corridors very expensive. The inability to alter rail tunnels due to the *Queensland Heritage Act 1992* means that rail transport of freight from west to east is limited across the range.

The Palmerston Highway is less steep and provides an opportunity for development of a transport hub at Mourilyan. There are possibilities for interstate and south-bound freight to use the inland route, avoiding coastal roads, but inland transport routes are narrow and not well sealed.

The Atherton Tableland generates significant volumes of freight from agricultural production and adjoining areas of pastoral holdings. Produce is sent to markets and ports on the coast via the Gilles and Bruce highways to Cairns and to the south via the Palmerston and Bruce highways.

There are existing freight routes from Mareeba through to Innisfail (inland) and Cairns to Innisfail (coastal) that are sufficient to support B-double freight. There are no B-double routes directly from Mareeba to Cairns.

Areas west of the Atherton Tableland (part of the North East Minerals Province) are rich in mineral deposits. Following the recent growth in mining activity in the North East Minerals Province, exploration in this area is expected to stimulate increased production of mineral ore and concentrate. The roads in the area are not designed for this level of freight and accelerated deterioration is likely, along with increased safety concerns.[13]

The region is well serviced by port facilities in Cairns Harbour and Mourilyan Harbour (see Map 6.3). The Port of Mourilyan is 20 km south of Innisfail and exports raw sugar and molasses from the Innisfail, Babinda, Tully and Atherton Tableland sugar growing districts. It includes onshore sugar and molasses handling and storage facilities and a single sugar loader and associated wharf. The Port of Cairns is a small multipurpose regional port catering for a diverse range of customers from bulk and general cargo (including bulk sugar) to cruise shipping, fishing fleet and reef passenger ferries.

There are five sugar mills operating in the region. These are located at Mossman, Gordonvale, Mareeba, South Johnstone and Tully.

Electricity supply in the region is problematic with tropical cyclones regularly impacting supply from the southern electricity plants. Installation of underground power lines has improved the situation in recent years; however, this is mainly a benefit to urban and residential power, not rural users.

Stanwell Corporation operates a hydro-generation facility on the Barron River. The 66 MW generation plant was established in 1963 and significantly upgraded in 2011 (including an additional 6 MW). The Kuranda weir operates as a regulating pond for the Barron Gorge Hydro. Flows can be improved by releases from Tinaroo Falls Dam upstream of the facility. The water is returned to the Barron River immediately downstream of the power station, where it is available for downstream users (mainly for domestic or urban purposes). The lower, coastal branches of the Barron River are tidal and saline, making the water generally unsuited to agricultural use. This water is used by a small number of sugarcane farms and for minimal other agricultural use.

The Tinaroo Hydro Power Station was designed to take advantage of water released for irrigation. Although only small scale, the 1.6 MW generation plant was commissioned in May 2004. Koombooloomba Hydro Power Station (7.3 MW) and Kareeya Hydro Power Station (86.4 MW), both on the Tully River, have a combined output of 91 MW of energy.

6.1.6 Vegetation

The Far North Queensland region is made up of three major terrestrial bioregions. The Wet Tropics and Einasleigh Uplands are the major coastal bioregions and the Gulf Plains is inland.

Some areas of land in the region are restricted from clearing under the *Vegetation Management Act 1999* (see Map 6.4)—429 348 hectares (5.9 per cent of the region) can be cleared, has been cleared or is naturally open and 163 329 hectares (2.2 per cent of the region) requires further verification or approval before clearing. Including national parks and state forests, 6.7 million hectares (91.9 per cent of the region) cannot be cleared. The region has 1.2 million hectares (17 per cent of the region) declared as World Heritage, national park or state forest.

13 Department of Infrastructure and Planning 2009, *Far North Queensland regional plan 2009–2031*, State of Queensland, ‹http://www.dsdip.qld.gov.au/resources/far_north_qld/fnq-regional-plan-2009-31.pdf›.

The inland bioregions have generally retained pre-European vegetation types and distributions. Inland vegetation is mostly open woodland dominated by *Eucalyptus* and *Corymbia* species with a grassy understorey. Other vegetation communities common in the region include paperbark woodlands, lancewood (*Acacia shirleyi*) dominated gravelly ridges within open woodlands, bluegrass communities (*Dichanthium* and *Bothriochloa* species, which occur as open grasslands on the undulating riverine plains and floodplains of major streams), salt marsh, mudflats, mangrove and sand dune communities (which occur in a broad coastal band), small areas of vine forest, the Wet Tropics rainforest systems (which occur in the higher rainfall eastern parts of the region) and riparian woodland and forest (which occur along the more permanent watercourses).[14]

The Wet Tropics natural resource management plan estimates that in 2005 wooded vegetation covered a little over 81 per cent of the coastal region. All catchments at this time retained over 50 per cent cover, with most retaining over 70 per cent and the Daintree over 95 per cent.[15] Clearing has been most evident in the coastal lowlands, along major river valleys and the Atherton–Evelyn tablelands.

The rate of clearing has slowed in the past 20 years. In the early 1990s, more than 3000 hectares were cleared each year in coastal areas. Of the 1837 hectares cleared over the period 1999–2001, 905 hectares (49 per cent) were cleared in the Herbert catchment, mainly for grazing. In the remaining catchments, clearing occurs in small patches for agriculture and residential development or in strips for linear service corridors.[15]

Forests in these areas are also sourced for a variety of commercial products, ranging from soil and gravel, seed and foliage, through to sawlogs and other timber products.

One of the critical issues for vegetation and biodiversity management is the extent, impact and number of ecologically significant invasive plants. Invasive plants in the region can be grouped in two categories:

- those recognised as weeds and posing a threat to land condition and biodiversity (e.g. rubber vine, grader grass)
- introduced pasture grass species that are considered important for improving grazing land condition, but can be a significant threat to biodiversity (e.g. buffel grass, gamba grass).

Other weed problems (in parts of the region) include annual ragweed, bellyache bush, castor oil plant, chinee apple, giant rat's-tail grass, giant sensitive plant, giant sensitive tree, Noogoora burr, rubber bush (calotrope), Siam weed, sicklepod, spiney emex, thornapples, neem tree and leucaena.[14]

At least eleven of the introduced plants known to occur (or potentially occur) in the region are listed as Weeds of National Significance—parkinsonia, lantana, rubber vine, prickly acacia species, indica, hymenachne, salvinia, mimosa, cabomba, parthenium weed, pond apple and bridal creeper.

Amendments to the *Vegetation Management Act 1999* (tabled in Parliament in March 2013) will remove constraints on clearing high-value regrowth vegetation on freehold land across the state, and create opportunities to clear vegetation for high-value agriculture. The audit mapping will be updated in the future to reflect these amendments when the laws come into force.

14 Northern Gulf Resource Management Group 2008, *Northern Gulf region: natural resource management plan 2008–2013*, Northern Gulf Resource Management Group, Georgetown.

15 FNQ NRM Ltd & Rainforest CRC 2005, *Sustaining the Wet Tropics: a regional plan for natural resource management 2004–2008*, FNQ NRM Ltd, Innisfail.

6.2 Current and potential agricultural land use

- The Far North Queensland region has a limitation with soil mapping. No soil data exists for approximately 5 per cent of the region (see Map 6.17).
- Large areas of the region are mapped at a scale that is too coarse for proper delineation of agricultural land. For example, the upper Herbert area is mapped at a scale of 1:100 000 and needs further refinement.
- The region includes a large area (740 566 hectares) that has World Heritage listing. This area has not been considered when calculating current and potential land uses (Table 6.2). However, there are small pockets of current production in this area: 0.3 hectares of annual horticulture, 44 hectares of perennial horticulture, 5 hectares of broadacre cropping, 6429 hectares of grazing, 4 hectares of intensive livestock production and 102 hectares of sugarcane. The remaining World Heritage Area is comprised of nature conservation and other land use (mostly managed resource protection or residual native cover and some production forestry).

Current production in the Far North Queensland region is determined by the microclimates of its sub-regions. The three zones (coastal, tableland and inland) each have distinct growing and production characteristics.

By land area (see Table 6.2 and Map 6.5), grazing is the largest land use in the region, representing over 75 per cent of current land use. This predominantly occurs in the western inland plain area and represents 3.7 per cent of the state's grazing land use.

Sugarcane and horticulture use less land as a percentage of the region; however, they both represent considerable proportions of the state's production areas for the relevant sectors (see Table 6.2 and Map 6.5). Sugarcane represents 1.6 per cent of the region's land use, but this is 20 per cent of the state's sugarcane production area. Similarly, perennial horticulture represents 0.4 per cent of the region, but this is more than 30 per cent of the state's perennial horticulture area.

The Far North Queensland region has sufficient land resources to support a significant expansion in irrigated agriculture. However, in most instances, such development will not occur without additional secure water supplies, viable markets and infrastructure development. Grazing country, occurring on areas of low production value, is already maximised (see Maps 6.12 and 6.13).

Agricultural development changes with time, driven predominantly by market forces. This can affect future demands for water, in particular the requirements for dependable supplies. An example is the movement of the industry from tobacco crops, which are less affected by prolonged drought periods and resulting water restrictions, to tree crops, which require a higher level of reliability of supply.[16]

One of the most significant opportunities, in size of potential area, is the upper Herbert catchment. The upper Herbert has a history of broadacre and fodder cropping, supporting the traditional dairy industry on the tablelands. With the reduction in the dairy industry and limited road infrastructure, cropping of this region was no longer considered economically viable.

The upper Herbert includes several thousand hectares of land with agricultural potential. The area varies from level alluvial plains along the river margins to rugged, deeply incised ranges. In the western areas of the upper Herbert the land is undulating, while to the east the topography rises irregularly and reaches altitudes of over 1000 m.

A study of the upper Herbert area indicated that approximately 1700 hectares was licensed for irrigation from surface water sources.[17] Although these systems flow reliably after the wet season and through to the middle of the year, water availability reduces rapidly during the annual dry season, when irrigation demands are at their peak. Demand often exceeds available supply during this time.

16 Department of Environment and Resource Management 2010, *Far North Queensland regional water supply strategy*, State of Queensland.

17 Department of Natural Resources and Water 2007, *Upper Herbert River water supply planning report: economic assessment of infrastructure*, State of Queensland.

Table 6.2 Current and potential land area

Queensland Land Use Mapping Program (1999 and 2009)	Current land use			Potential land use*	
	Area (ha)	Percentage of region	Percentage of ALUC† that occurs in region	Area (ha)	Percentage of region
Broadacre cropping	21 211	0.29	0.60	659 851	9.01
Sugarcane	113 689	1.55	20.12	850 367	11.61
Perennial horticulture	27 317	0.37	31.10	951 867	12.99
Annual horticulture	1 302	0.02	2.76	939 815	12.83
Grazing	5 518 440	75.32	3.73	5 830 712	79.57
Sown pastures§	255 208	3.48	1.59	733 623	10.01
Intensive livestock	400	0.01	1.06	1 078 509	14.72
Aquaculture	996	0.01	21.91	7 453	0.10
Other land use (non-agricultural land uses and also may include some forestry)	1 643 245	22.43	8.19		
Agricultural land class data gap	350 143	4.78			
Total	**7 326 600**	**100.00**			
Forestry‡ (see Section 6.2.2)					
Managed in silvopastoral systems (mixed native or plantation forestry and grazing)	5 192 111	70.86	2.70		

Note: Refer to Sections 6.2.2 (under 'Forestry') and 6.3 ('Data confidence') for a further explanation regarding the forestry datasets and methodology used.

* Potential areas include where the majority of current production occurs as well as where production could potentially occur. Refer to Section 6.3 ('Data confidence').

† Agricultural land-use category.

‡ Forestry includes land, irrespective of tenure, that has been established as forestry (native or plantation), but can also be used for other purposes such as grazing. Current plantation forestry locations are developed from data from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), HQPlantations Pty Ltd and Forest Enterprises Australia Holdings. Current native forestry is based on data from the Department of Agriculture, Fisheries and Forestry (Queensland) and the Department of Environment and Heritage Protection. See Section 6.2.2 (under 'Forestry') for further information about forestry data.

§ Sown pasture potential is to be considered in addition to currently sown pasture areas. An estimate of total potential of sown pastures for the region needs to consider both areas currently sown as well as those with potential for sown pastures.

6.2.1 Important agricultural areas

In the Far North Queensland region, three areas have been identified as important agricultural areas.

An important agricultural area is an area that has all of the requirements for agriculture to be successful and sustainable, is part of a critical mass of land with similar characteristics and is strategically significant to the region or the state. Map 6.6 shows the general location of the important agricultural areas for the Far North Queensland region.

The Mareeba Dimbulah Water Supply Scheme area and the Atherton Tableland have a small section of overlap. This land is recognised as important to the development of both areas.

Mareeba Dimbulah Water Supply Scheme area

The Mareeba Dimbulah Water Supply Scheme area is historically known as the Mareeba Dimbulah Irrigation Area. This area has great potential but is also important to current agricultural production. It is located partly on the Atherton Tableland and extends from Tinaroo Falls Dam to the towns of Mareeba, Dimbulah, Walkamin and Biboohra.

The Mareeba Dimbulah Water Supply Scheme was established in the mid-1950s to support the tobacco industry, and passes through areas with elevations ranging 400–600 m above sea level. Tinaroo Falls Dam on the Barron River provides the area with the majority of its water requirements, although supplies may also be diverted from Collins Weir on the Walsh River.

The region has a very reliable water supply. Announced allocations are determined at the start of the water year (in July) and may be revised throughout the year, depending on storage inflows. Due to the large capacity of Tinaroo Falls Dam, the announced allocation in the Mareeba Dimbulah Water Supply Scheme has been met in most years, with allocations of less than 100 per cent uncommon.[18] However, announced allocations of less than 100 per cent have become more common in recent years.

Plantations of mango, banana, pawpaw, avocado, lychee, macadamia, citrus and other nuts and fruits have been established. Sugarcane is the dominant crop, with production across the whole Mareeba Dimbulah Water Supply Scheme area but mainly around the Arriga flats and the mill. Irrigation of pastures for beef cattle fattening and stud breeding also occur in the area.[19] The area has significant access to good-quality soils and reasonably flat, arable land for development of cropping.

There are also small areas of irrigation (supplemented from the Mareeba Dimbulah Water Supply Scheme) in the Clohesy River and Davies Creek area, between Mareeba and Kuranda. These are used predominantly for horticulture and some cropping.

There are extensive networks of roads, good access to labour and other important infrastructure to support agricultural development. The local community has established on-site accommodation to support labour.

The development of more on-farm storage by irrigators has provided greater flexibility in controlling irrigation supply during peak periods and allows for opportunistic storage of water during off-allocation periods. In certain areas, local run-off and irrigation tailwater can also be harvested to the off-stream storages.

Atherton Tableland

The Atherton Tableland supports four different microclimates based on altitude:

- the Mareeba–Dimbulah area at 400–500 m above sea level
- the Walkamin–Atherton area at 600–700 m above sea level
- the Evelyn Tableland area at 800–900 m above sea level
- extensive rolling hills between Malanda and Milla Milla that are predominantly grazed for cattle and dairy production.

The four microclimates allow for diversity of production systems, varieties and growing conditions. Due to this, the area has become well known for its contribution to regional and statewide agricultural production.

The Tablelands local government area contributed 42 per cent ($334.1 million) to the Far North Queensland total value of agricultural commodities in 2010–11. This was primarily fruit production valued at $107.7 million (29 per cent of the region's production and 12.5 per cent of the total state production) and grazing valued at $107.9 million (92 per cent of the region's production).

18 Gutteridge Haskins & Davey Pty Ltd 2001, *SWP distribution system efficiency review—report on Mareeba Dimbulah Irrigation Area*, study undertaken on behalf of Department of Natural Resources and Mines, Queensland.

19 SunWater, 'Mareeba–Dimbula', SunWater, viewed 29 January 2013, ‹http://www.sunwater.com.au/schemes/mareeba-dimbulah›.

The area provides 76 per cent of the state's lime commodity value, 65 per cent of the value of pawpaw production and 56 per cent of the fresh market potato commodity value. Also, it produces regionally distinct crops such as tea, which require specific altitudes and growing conditions.

Southern coastal area

The southern coastal area of the Far North Queensland region has long-established production in bananas and sugarcane. More than 90 per cent of Australia's bananas are grown in Queensland, the majority in the high-rainfall coastal strip between Cardwell and Babinda. The industry is centred around Innisfail and Tully.[20] The annual production of bananas in the Tully–Innisfail area (Cassowary Coast local government area) represents 84 per cent of the state's production and was valued at $236.2 million in 2010–11.

Pawpaw are also grown in the Cassowary Coast local government area. They represent 29 per cent of the state's production value and were valued at $4.6 million in 2010–11.

Sugarcane production in the region is also considerable. The Tully mill is one of the largest in Queensland and production in the Cassowary Coast local government area in 2010–11 was valued at $101.2 million (11 per cent of the state production value and 51 per cent of the value for Far North Queensland).

The region is vulnerable to cyclones, but the industries have adopted new production systems to minimise future cyclone impacts.

The region is well established in terms of backpacker accommodation, other accommodation options and labour support services. Cairns and other coastal attractions are close by.

See Case study 6.1 for more information on the banana industry in this area.

6.2.2 Industry profiles

Broadacre cropping

Current

Broadacre cropping (not including sugarcane) accounts for 0.3 per cent of the region's land use (21 211 hectares).

In 2010–11 a small number of broadacre crops were grown in the region. The majority of these were maize, field beans, pasture seed, peanuts, soybeans and sugarcane (see 'Sugarcane' on page 227). Peanuts, maize and pasture seed are the largest value broadacre crops in the region, representing $5.8 million, $2.8 million and $2.1 million respectively.[21]

Pasture seed and peanuts grown in the Far North Queensland region represent a large proportion of the total crop grown in the state—49 per cent for pasture seed and 39 per cent for peanuts. Peanut, maize and pasture seed production is primarily in the Tablelands local government area; a small amount of peanut production occurs in the Cairns local government area.

Irrigated cropping occurs throughout the tablelands and along the Walsh River to the west of the ranges. Small areas of irrigated cropping are established near Julatten in the north, along the Clohesy River, along the Herbert River and between the Herbert and Beatrice rivers in the south of the region.

20 Australian Bananas, 'Banana facts: growing', Australian Bananas, viewed 4 February 2013, ‹http://www.australianbananas.com.au/banana-facts/growing›.

21 Australian Bureau of Statistics 2012, Value of agricultural commodities produced, Australia, 2010–11, cat. no. 7503.0, Australian Bureau of Statistics, Canberra, ‹http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/7503.0Main+Features12010-11?OpenDocument›.

Peanuts are a traditional, long-established crop for the Tablelands local government area. A range of varieties are grown, with shelling and grading undertaken at the Peanut Company of Australia's plant at Tolga. The peanuts are transported to Kingaroy in southern Queensland for further processing.

The agricultural land used for broadacre cropping in the Mareeba Dimbulah Water Supply Scheme area is supported by the development of extensive water supply infrastructure in association with the Tinaroo Falls Dam. Broadacre crops in this area include maize, soybeans, peanuts, mungbeans and pasture seed.

Coastal dryland cropping is predominantly sugarcane with other broadacre crops grown in tandem or in rotation with the sugarcane crops (see 'Sugarcane' on page 228).

Potential

Approximately 9 per cent of the region has been identified as having potential for broadacre cropping, mostly in the Mareeba Dimbulah Water Supply Scheme area (see Table 6.2 and Map 6.7). Of the land identified as having potential, 75 per cent is currently used for grazing and 14 per cent for sugarcane production.

The region has a number of features that make it a viable option for expansion of broadacre cropping. The Mareeba Dimbulah Water Supply Scheme area and the area between Tolga and Ravenshoe have strong potential (although portions of these areas are currently used for dairy production and are not suited to broadacre cropping). These parts of the region have good transport networks and access to coastal markets. Population centres are within easy access to the growing areas, so there is support for long-term labour and services.

However, the allocation of water supplies from the Mareeba Dimbulah Water Supply Scheme is currently maximised. The only way new land can be developed for irrigated cropping is by the transfer of existing unused allocation or by the development of cropping that can access currently unused allocations. Further supply could be gained by improving the efficiency of irrigation and the supply scheme distribution. To fully use the area of suitable cropping land, a new irrigation supply will have to be developed.

In the inland areas, reliable water supplies are needed to provide irrigation for year-round production. Road transport in the south-western areas of the region is limited due to poor road infrastructure. The biosecurity threat throughout the region due to feral pig numbers is considerable.

The Herbert River area, which has a history of cropping of sorghum and maize to support local dairy production, has potential as a prime area for broadacre cropping development. Currently, the biggest limitations to development in this area are vegetation management restrictions and unreliable water supply. Studies conducted by the Department of Natural Resources[22, 23] over the past 15 years have identified more than 100 000 hectares of land suitable for irrigated broadacre cropping. There are also areas of potential south-west of Herberton.

The surface geology of the Herbert River area is an obstacle to growing broadacre crops on a large scale. While there is a wide range of soils, including extensive areas of deep red and yellow kandosols, chromosols, grey sodosols and other cropping soils[24], the area is predominantly a soil base of basalt rock. The lack of uniformity of land resources makes broad-scale cropping problematic.

22 Enderlin, NG & Neenan, DW 2000, *An assessment of land suitability for irrigated agriculture in the upper Herbert River catchment and Kaban areas, North Queensland*, Department of Natural Resources, Queensland.

23 Grundy, MJ & Heiner, IJ 1998, *Land resources of the Ravenshoe – Mt Garnet area, North Queensland: II. Land suitability*, Department of Natural Resources, Queensland, land resources bulletin: DNRQ980122.

24 Heiner, IJ & Grundy, MJ 1994, *Land resources of the Ravenshoe – Mt Garnet area, North Queensland: I. Land resources inventory*, Department of Primary Industries, Queensland, land resources bulletin: QV94004.

There have been promising results from recent research and development into expansion of upland rice production in the tablelands and the Julatten area north of Cairns. Paddied rice has had a mixed success in the Far North Queensland region in the past; however, the initial outcomes of upland rice research are favourable and the potential for expansion of broadacre cropping is favourable, particularly in rotation with existing broadacre crops. The Mareeba Dimbulah Water Supply Scheme area has had proven success with rice cultivation.

Private-sector investment has helped establish a processing and production facility for rice, grains and pulses south of the region in Brandon (south of Townsville), to support North Queensland's broadacre cropping industry. This facility was established to export grains, rice and pulses out of the Port of Townsville.[25]

Sugarcane

Current

Sugarcane is the predominant broadacre crop of the Far North Queensland region, contributing approximately 95 per cent of the total broadacre value of commodities produced in the region in 2010–11. Sugarcane provided $196.6 million of the total broadacre value of $205.4 milllion in the region and 21.6 per cent of the state's value of sugarcane production.

Sugarcane is grown in the eastern areas of the region. In 2010–11, the values of sugarcane produced from the Cassowary Coast, Cairns and Tablelands local government areas were $101.2 million (51.5 per cent of the region's total), $69.7 million (35.5 per cent of the region's total) and $25.7 million (13.1 per cent of the region's total) respectively.

Raw sugar is an internationally tradeable commodity and currently has a high world price. Because of this, sugarcane production in Far North Queensland has been extended into areas that would not traditionally grow sugarcane. Areas such as Julatten in the north are trucking cut sugarcane into Mossman for processing. In periods of poor raw sugar prices, this would not be viable.

Potential

Approximately 11 per cent of the region has been identified as having potential for sugarcane production (see Table 6.2 and Map 6.8). Of land identified as having potential for sugarcane, 83 per cent is currently used for grazing and 10 per cent is used for sugarcane production. The remaining 7 per cent is used for a mixture of agricultural and non-agricultural purposes.

The Mareeba mill is undergoing expansion to process additional sugarcane harvest and also to process syrup into raw sugar. This provides potential for an immediate increase in sugarcane cultivation in the surrounding area.

The upper Herbert River area has been identified as having potential for sugarcane, but poor transport and lack of infrastructure limit this development. The Herbert River area is currently an established grazing region and provides high-quality grazing opportunities. Overall, transport infrastructure to existing mills is limited; however, improvements to the Kennedy Highway have been undertaken. Climate is also a minor limitation, with lower than ideal temperatures throughout the year. Water access in the area would need to be considered and more detailed mapping would be required to identify basalt flows and underlying geology. If raw sugar prices remain high, potential sugarcane production in the upper Herbert may warrant investment in a mill.

Similarly, areas of the Mitchell River catchment within the Far North Queensland region are considered to have biophysical potential; however, this is not economically viable within the current industry structure and infrastructure constraints. As with the Herbert River area, the Mitchell River area is currently grazing country.

25 McKillop, C 2012, 'Sugar still king but rice is back in the Burdekin', ABC Radio, Country Hour, viewed 5 June 2012, ‹http://www.abc.net.au/rural/qld/content/2012/06/s3518562.htm›.

Areas that offer the most potential for development of the sugarcane industry are expansions on existing growing areas. These are areas that have established irrigation systems, access to mill processing, sufficient road infrastructure and high solar radiation for optimal biomass production (such as the Mareeba Dimbulah Water Supply Scheme area).

Horticulture

Current

The Far North Queensland region is a strong horticultural growing region. The unique combination of tropical climate, fertile soils and abundant water are ideal conditions for a range of valuable fruits and vegetables. The crops are predominantly perennial crops, with a small number of annual crops. Tropical fruit is the major horticultural commodity grown.

Almost 43 per cent of the state's fruit production and 3.5 per cent of the state's vegetable production occurs in the Far North Queensland region.

Horticultural production (perennial and annual) accounts for 0.4 per cent of the region's current land use (28 619 hectares).

Soil type varies markedly from Atherton in the south to the Mareeba area in the north. Typically soil on the southern tablelands is red, structured, high-clay soil with an acid-neutral pH; it is well drained, has good fertility and is derived from basalt. In contrast, soil in the Mareeba–Dimbulah area is sandy loam to sandy clay loam over a red, structured, coarse sandy clay soil with a slightly acid pH; it is well drained, is derived from granite and has inherent low fertility.[26]

The Mareeba Dimbulah Water Supply Scheme area supports a wide range of horticultural crops including mangoes, avocados, citrus fruit (mostly limes), tropical fruit, cashew and macadamia nuts, bananas, onions, melons, sweet potatoes, herbs, coffee, tea-tree (oil) and pineapples. Annual horticulture production in the Mareeba area has diminished in recent years with fewer pumpkins, tomatoes and capsicums grown in the area. Annual production is transported by road to Cairns and onwards to southern markets.

The coastal areas provide a good climate and good soils for horticulture. Bananas are located in this region due to specialised climatic adaptation to the region. This adaptation is unusual for a perennial crop. Bananas grown in the Far North Queensland region account for 98.5 per cent of the state's total value of banana production.

Water is considered the major limiting factor as the irrigation and water requirement for bananas is quite high. While the coastal areas get good annual rainfall, it is not consistent throughout the year. Irrigation is required during the dry season to supplement rainfall.

The Cassowary Coast and Cairns local government areas contribute 30 per cent of the state's value of commodity for fruit. This includes 62.5 per cent of the state's value of rambutans, and similarly 89.1 per cent for bananas and 33 per cent for pawpaws.

In 2010–11, over 45 per cent of the state's value of commodity for potatoes and 22 per cent of that for pumpkins were produced in the Tablelands local government area.

While other areas of the state's vegetable growing regions have faced water shortages and restrictions in the past 10 years, Far North Queensland has maintained a substantial water supply. The primary growing area for annual horticulture is around Tolga, Kairi and Atherton. Lime production is strong in the region, with 79 per cent of the state's production (valued at $16.8 million) occurring in the Tablelands local government area.

26 Tablelands Futures Corporation 2007, *Atherton Tablelands: Cairns highlands investment environment—tropical northern Australia*, Kleinhardt Pty Ltd, viewed 26 October 2012, ‹http:www.kleinhardt.com.au/files/65/Investment%20Profile%20-%20TablelandsFinal010507.pdf›.

Potential

Approximately 13 per cent of the region has been identified as having potential for perennial horticulture production and 13 per cent for annual horticulture production (see Table 6.2 and Maps 6.9 and 6.10). Of land identified as having potential for either perennial or annual horticulture, 95 per cent is currently used for grazing.

Horticultural produce is transported by road to southern markets. Roads are often blocked due to extreme rainfall and flooding; this affects bananas predominantly. Crops that are harvested before or after the wet season (such as mangoes and avocados) are less affected by limited road transport. During these blockages, produce can be held in storage for a while depending on cold-chain limitations.

Many areas with potential for horticultural production within the Mareeba Dimbulah Water Supply Scheme are considered favourable for development. Labour infrastructure, including on-site accommodation and localised support for workers, is well established. Water supplies are reliable and transport infrastructure to the major population centres is largely established, but still requires further improvements.

Developing new banana (and, to a lesser extent, pawpaw) plantations in the Tablelands local government area and Cape York region could be part of a risk management strategy. Expansion of these industries further across the region would provide a buffer for the industry against mass production losses that are caused by extreme weather such as cyclones.

Temperature variations in the inland areas limit the types of crops that can be successfully grown.

Case study 6.1 Bananas in Far North Queensland

The influence of temperature on the Queensland banana industry

Horticultural crops are particularly sensitive to temperature, as most have specific temperature requirements for optimum yield and quality. Temperature determines, to a great extent, the production season and location, yield and quality performance of the majority of horticultural commodities in Australia, including bananas.

Although bananas can be (and have been) grown in many frost-free locations in Queensland and New South Wales, most of Australia's bananas are currently grown in the tropics of northern Queensland.

The majority (over 90 per cent) of the industry is centred around the Innisfail and Tully areas. These areas have dry season average rainfalls of 1374 mm and 1561 mm and wet season average rainfalls of 2549 mm and 2203 mm respectively.

Much smaller areas of banana production occur on the Atherton Tableland, in northern New South Wales (from around Coffs Harbour north to the Tweed River) and in south-eastern Queensland (as far north as Bundaberg). Also, there are small commercial plantations in Western Australia (around Carnarvon and the near the Ord River at Kununurra) and near Darwin in the Northern Territory (see Table 6.3).[27]

Even if suitable soils, good-quality irrigation water and profitable markets are available, temperature will limit profitable banana production to specific locations in Queensland.

Table 6.3 Australian banana production 2003–09 (tonnes)

Year	New South Wales	Queensland	Western Australia	Northern Territory	Total
2003	31 213	256 016	5 786	931	293 946
2004	10 031	236 883	5 819	856	253 589
2005	7 858	253 048	3 545	132	264 583
2006	11 352	88 852	4 647	203	105 054
2007	12 574	256 668	4 689	209	274 140
2008	11 493	277 926	5 335	65	294 819
2009	10 297	254 656	4 203	18	269 174

Source: Australian Banana Growers Council

The effects of Cyclones Larry and Yasi on the Queensland banana industry

In 2006, Cyclone Larry destroyed almost 90 per cent of the banana crop in northern Queensland. As 90 per cent of Australia's commercial bananas are grown in this area, all Australians felt the impact of this, with banana prices exceeding $15/kg (compared to the average for 2005 of $3/kg).

In the June quarter of 2006, the higher prices for all fruit contributed 0.6 percentage points to inflation, and bananas contributed the majority of this.

Production recovered from Cyclone Larry, with production for 2010 over 300 000 tonnes. However, in February 2011 Cyclone Yasi damaged 75 per cent of the Australian banana industry, with the major impact on Tully and Innisfail. Production recovered more quickly than post-Larry, with significant volumes returning to the market from Innisfail in 7 months.

27 Australian Bananas, 'Banana facts: growing', Australian Bananas, viewed 4 February 2013, ‹http://www.australianbananas.com.au/banana-facts/growing›.

After Cyclone Larry, it was clear that the industry needed to diversify its geographical spread, and this has been confirmed following the impact from Cyclone Yasi. However, although diversification to reduce risk is a priority, it cannot be at the expense of productivity, quality or the industry's ability to deliver consistent supply. Geographical diversification while maintaining productivity may only be possible with diversification of the product line.

Recent research has assessed the impacts of those cyclones and investigated how to reduce such impacts in the future. It has considered a range of strategies for managing cyclone impacts including pre-cyclone options (such as removing the leaf canopy to reduce wind resistance, which would reduce plant and subsequent production losses) and post-cyclone strategies (such as staggering crops to avoid production gluts, which were a feature of the most recent post-cyclone banana supply).

Intensive livestock

Current

Intensive livestock production in the Far North Queensland region accounts for less than 0.01 per cent of the region's current land use (400 hectares). The values of commodities produced in the intensive livestock sector in the region are poultry meat $30.7 million (7.7 per cent of the state's total production), egg production $0.9 million (0.6 per cent), whole milk production $35.0 million (13.7 per cent) and pig meat $2.5 million (1.1 per cent). Total cattle and calf sales from the region were $83 million in 2010–11.

Large beef processing facilities are located in the tablelands at Tolga and there are a number of smaller processing facilities throughout the region. These facilities support both cattle from feedlots and grazed cattle.

In the past, pig production was aligned with dairy production, as waste milk products from the dairies were used in piggeries. From this history, there is a small pig production industry remaining in the tablelands, although dairying has declined considerably. Currently there are three registered pig production enterprises, supplying mainly local markets and using small local processing facilities.

Establishment of a chicken meat processing facility on the tablelands has led to increased poultry production in the area. This facility employs approximately 150 people and has significantly increased output in recent years to supply northern Queensland's fresh chicken market.

The area north of Ingham through to south of Innisfail has some of the largest aquaculture businesses in Queensland. Aquaculture accounts for 0.01 per cent of the region's land use (996 hectares). In the coastal area, prawn and barramundi farming is significant (both terrestrial and sea-cage rearing, although sea cages were significantly damaged in Cyclone Yasi). Red claw farms are predominantly on the tablelands, along with freshwater fish farming.

Traditionally dairy was a significant industry in the tablelands. Local processing facilities supported the industry and employed large numbers of residents. However, the industry has declined from its peak in 2000 of 185 dairy farms to 65 farms in 2010.[28] This is due to decreasing farm gate prices and increasing input prices as well as other socio-economic factors.

Potential

Intensive livestock enterprises should be located within reasonable transport distances of grain supplies (to minimise the cost of feed) and close to processing facilities (to address animal welfare needs in the case of poultry and food safety needs in the case of dairy). This results in production occurring around grain growing areas and relatively close to processing facilities. Approximately 15 per cent of the region has been identified as having potential for intensive livestock production (see Table 6.2 and Map 6.11).

28 Spies, P 2010, *Tableland rural industry workforce survey—report*, Tableland Industry Workforce Group Inc., ‹http:www.thinktnq.com.au/research/8/6/doc-122›.

Expansion of feedlot activities in conjunction with the development of broadacre and fodder cropping enterprises would be possible in the upper Herbert River area, provided infrastructure (such as irrigation and water storages) and road transport were further developed.

Coastal finishing of cattle from western Queensland provides significant opportunity for feedlot expansion in the region. However, climatic factors (such as high rainfall and its impact on waste and odour management) need to be considered.

The region has an area of potential expansion of aquaculture along the coast of 7453 hectares (0.1 per cent of the region). The soil, slope and access to water make these areas feasible sites. Currently, most products are road freighted for domestic markets, but small amounts are air freighted internationally. Planning considerations may impact the establishment of new aquaculture development areas.

There are significant temperature limitations to the expansion of poultry in the region. Temperature management in sheds would be integral to the establishment of new poultry production enterprises.

Based on the declining numbers in recent years, the region is not considered a potential growth area for dairy unless an export market for fresh milk supplies can be secured. This would depend on the development of extended shelf-life storage and improved shipping technology.

Grazing

Current

Grazing livestock production in the Far North Queensland region accounts for 75 per cent of the region's current land use (5.5 million hectares; see Table 6.2).

The majority of extensive grazing occurs in the western portion of the region in areas with less productive soils and less reliable seasonal rainfall. The eastern part of the region, encompassing the tablelands and the coastal areas, has more intensive and smaller properties (primarily fattening enterprises) with more fertile soils and more reliable and higher rainfall. The extensive grazing that occurs in the western part of the region is primarily based on native pastures including the blackspear, *Aristida*/*Bothriochloa* and bluegrass/browntop communities. There are some areas with non-native pasture species on better pockets of more fertile soils and a moderate amount of introduced legumes (stylos) at a low density across the region. Sown pastures account for 255 208 hectares (3.5 per cent of the region; see Table 6.2).

Over the last two to three decades, the western breeding properties have invested in sustainable stocking rate management, infrastructure (such as fencing and water systems) to implement wet season spelling and fire programs to control woodland thickening and exotic weeds.[29] However, this expenditure has recently slowed with rising debt levels, static cattle prices and falling property prices. A recent analysis shows that while cattle prices remain static, overheads and direct costs per livestock unit have increased by 54 and 150 per cent respectively. With more than a two-fold increase in land values over the last decade, debt levels now average $976 000 per business.[30] Graziers are lifting herd productivity by focusing on nutrition, breeder management systems, improved genetics and disease control.

The tablelands and coastal areas of Far North Queensland have the highest quality grazing country in the region. Most pastures in these areas are dominated by introduced grasses and legumes to maximise liveweight gain. There is a small amount of irrigated introduced pasture on the tablelands for beef cattle. Beef properties on old dairy farms are using existing irrigation infrastructure to irrigate pastures and/or grow rye grass during winter.

29 Northern Gulf Resource Management Group 2008, *Northern Gulf region: natural resource management plan 2008–2013*, Northern Gulf Resource Management Group, Georgetown.

30 Broad, KC, Bray, SG, English, BH, Matthews, RA & Rolfe, JW 2011, 'Adapting to beef business pressures in the Gulf', *Proceedings of the Northern Beef Research Update Conference*, North Australian Beef Research Council, ‹http://www.jackiekyte.com.au/nabrc/public/files/NBRUC_2011_Proceedings.pdf›.

The tablelands and coastal grazing areas are often used for finishing off cattle from the western areas. It is difficult for the tablelands cattle growers to source the genetics and weight for age they are after from the western region, as previously the region genetics has focused on drought resistance and pregnancy rates. The tablelands graziers seek animals with greater weight gain potential.

Generally, pastoral holdings increase in size moving from the western edge of the Atherton Tableland towards the Gulf. Owing to the harsh environmental conditions and poor road access during (and for intermittent periods following) the wet season, a high proportion of the properties in the region are breeder properties.

Young cattle, old cows and bullocks are 'turned off' at the end of the wet season. Most of the young cattle are transported to other properties to be grown out and fattened, or are sold for live export. The old livestock are sold primarily to export beef markets, but some are sold for domestic consumption. To a much lesser extent (and primarily in the upper basin areas), cattle are fattened for higher value domestic and export beef markets.[31]

Potential

Approximately 80 per cent of the region has been identified as having potential for improved grazing animal production (see Table 6.2 and Map 6.13).

The biggest restrictions on the western area of grazing are limited water access and grazing circles around watering points. There are significant areas of underused land in the region outside the grazing circles. There is potential to improve water access and increase development of extensive breeding properties. Development needs to occur on the best land areas first, where the return on investment would be the greatest.

There has been a steady increase in native woodland density in this region over the last 50 years and the ability to control this is currently restricted. Grass production could be increased if the density of trees was reduced.

There are irrigation opportunities for growth of forage crops; however, irrigated pastures are not profitable at present in Far North Queensland. In the past 10 years the level of supplementary feeding has increased, but this will reduce with declining profitability. There is potential to increase sown pastures by an additional 10 per cent across the region (see Map 6.14).

There are opportunities for increased grazing and timber production (silvopastoral systems) in some native forested grazing areas where commercial timber species naturally occur. Managing trees through thinning and harvesting (to reduce competition, allowing the remaining trees to grow larger and more quickly) also reduces competition on pastures, resulting in increased grazing production.

Forestry

Current

Far North Queensland is currently a small to medium forestry production and timber processing region in Queensland. The region currently generates less than 5 per cent of Queensland's softwood forestry production and less than 5 per cent of hardwood forestry production for the Queensland timber processing industry. There is, however, a large-scale 'timber salvage' operation being finalised as a result of tropical cyclone damage—this will be completed in 2013. Forestry production predominantly comes from timber resource areas (native and plantation) on state-owned lands administered under the *Forestry Act 1959*, native forest practice notification areas on private (freehold) land under the *Vegetation Management Act 1999* and plantation forestry on private land (see Map 6.15). Almost all of this land is also grazed and generally managed as silvopastoral systems (production systems that combine forestry and grazing in a mutually beneficial way).

31 Economic Associates 2006, *Mitchell draft water resource plan—economic and social assessment report*, Department of Natural Resources, Mines and Water, Queensland.

Plantation forestry covers over 15 000 hectares (0.2 per cent of the region) and is predominantly softwood (see Map 6.16). However, before 2011, the region's plantation forestry estate totalled almost 25 000 hectares. In 2011, Cyclone Yasi caused severe damage to over 20 000 hectares of Far North Queensland's softwood and hardwood plantation resources. Since Cyclone Yasi, most of the previous hardwood plantation forestry (which totalled approximately 12 000 hectares) has been changed or is in the process of being converted to sugarcane cropping or horticulture. Plantation forestry produces a number of forest products including sawlogs, round timbers and pulpwood for a broad range of appearance and construction timber processing purposes, plus aromatic timber (exotic sandalwood).

The hoop pine and exotic pine softwood plantations in the region were mostly established by the Queensland Government for sawlog production from the 1930s and 1980s respectively. Hardwood plantations in the region were established from the 2000s by private investors. The estate on state-owned land was licensed, and that on freehold land was sold to private interests in 2010 by the Queensland Government.

The region's plantation forestry areas, including fallow areas, cover approximately 10 000 hectares of exotic pine softwood near Cardwell, approximately 3000 hectares of exotic pine and native hoop pine on the Atherton Tableland, just over 2000 hectares of teak hardwood plantations between Innisfail and Ingham and a series of small single-species and mixed-species plantations scattered through the higher rainfall areas (see Map 6.16). The hardwood and sandalwood plantations are presently immature and expected to come onstream for harvest after 2020.

Native forestry currently occurs across the region, generally on land that is also used for grazing (see Map 6.15). The region produces a number of native forest products including sawlogs, poles, bridging girders, fencing timbers and craftwood for a broad range of appearance and construction and mining timber processing purposes. In addition, native Queensland sandalwood is harvested for its aromatic timber properties (not mapped). The key commercial native forestry tree species in the region include various spotted gums, red gums, ironbarks, bloodwoods and stringybarks, Moreton Bay ash and Queensland sandalwood.

On state-owned land, the denotation of a management unit (MUID)[32] on the lot on plan indicates commercial native forestry (or quarry material) interest. However, the actual native forest production area is generally restricted to the forested area within the parcel. So although there are currently timber interests based on MUIDs on 5.1 million hectares, which is 70.0 per cent of the region (Table 6.4), this figure is not the actual area of native forestry production on state land. These forested areas include land that potentially has areas of native Queensland sandalwood. Harvesting of these MUIDs is scheduled on a routine basis in conjunction with the current state timber supply commitments and market demand.

Native forestry on private (freehold) land forest practice notifications (which involves managing, selective felling and removal of native trees for commercial purposes) covers 47 580 hectares (0.7 per cent of the region). The actual area of production is generally restricted to the forested areas within those areas (see Table 6.4).

The region supports two medium-sized softwood processing facilities as well as a number of small processing facilities within or just outside the region that process hardwood native timber from the region's forest products (Maps 6.15 and 6.16). There are also a number of portable sawmills and fencing timber processors (not mapped) that source the region's forest products. Commercial haul distances can be 400 km or more, although the value of the product will determine economical haul distances.

32 MUID—management unit inventory data.

Potential

There is potential for increased forestry production in the region from native hardwood, plus from softwood and hardwood plantation resources. However, for plantation forestry, the risk of cyclone damage will need to be carefully considered, given the recent experience with plantations in the region. Increased forestry production would provide further resources for existing timber processing facilities within and near to the region once increased supply comes onstream.

The areas identified for potential native forestry expansion in Far North Queensland are reasonable—high potential 383 814 hectares, medium potential 854 777 hectares and low potential 3 105 986 hectares (5.2, 11.7 and 42.4 per cent respectively of the region's area—see Map 6.15 and Table 6.4). Opportunities exist to increase native forestry production on the mapped potential areas on a long-term basis while having minimal impacts on the other pastoral land uses, creating silvopastoral systems.

The area identified for potential plantation forestry expansion is generally limited to the higher rainfall areas—hardwood 685 584 hectares and softwood 666 078 hectares (9.4 and 9.1 per cent respectively of the region's area—see Map 6.16 and Table 6.4). The current land uses of land that has potential for hardwood plantation are grazing (66.4 per cent), sugarcane (15.7 per cent) and other uses (9.7 per cent). Those for land that has potential for softwood plantation are grazing (62.9 per cent), sugarcane (15.2 per cent) and other land uses (12.8 per cent).

Silver quandong, Gympie messmate, kauri pine, cheesewood (Leichhardt) and Indian sandalwood (irrigated) plantation varieties, plus perhaps exotic pine, are considered some of the best options for plantation expansion in the region, particularly due to their high resistance to cyclone damage. However, as stated above, the risk of cyclone damage should be carefully considered given the recent experience with plantations in the region.

Most existing timber processors in the region have some capacity to expand production if increased log timber comes onstream. Demand for native hardwood forest products is high and demand for exotic and native softwood plantation forest products is medium to high. Demand for forest products is forecast to remain strong in the medium to long term.

The region has a high risk of severe cyclone damage, which is a constraint to plantation expansion. However, it also has:

- areas with good rainfall and suitable soils (in the areas mapped as potential) that could produce commercial growth rates for plantation silver quandong, Gympie messmate, kauri pine, cheesewood (Leichhardt), Indian sandalwood (irrigated) and exotic pine species
- some areas with relatively affordable land prices (in the areas mapped as potential)
- potential access to a range of existing timber processing facilities, domestic markets (Cairns and Townsville) and port facilities (Townsville and Mourilyan Harbour).

Overall, the region has small forestry production output, largely due to the constraints discussed earlier. However, there is some opportunity for forestry production growth, which in turn would provide the opportunity for industry investment and growth in the associated down-stream timber processing.

Table 6.4 Current and potential land area for forestry

Forestry†	Current land use			Potential land use*	
	Area (ha)	Percentage of region	Percentage of ALUC‡ that occurs in region	Area (ha)	Percentage of region
Plantation forestry (ABARES, HQPlantations, FEA Holdings)					
Hardwood	2 459	0.03	5.89	685 584	9.36
Softwood	12 465	0.17	6.01	666 078	9.09
Mixed species (softwood and hardwood)	18	0.00	5.94	377 164	5.15
Fallow (where plantation not currently planted to trees)	565	0.01	3.23		
Total	**15 507**	**0.21**			
Native forestry					
State-owned land timber interests (area based on entire lot on plan; forestry restricted to forested area within that)	5 129 025§	70.00	5.19		
Private land (native forest practice notifications)	47 580	0.65	1.47		
High potential				383 814	5.24
Medium potential				854 777	11.67
Low potential				3 105 986	42.39
Total	**5 176 605**	**70.65**		**4 344 577**	**59.30**

* Potential areas include where the majority of current production occurs as well as where production could potentially occur. Refer to Section 6.3 ('Data confidence').

† Forestry includes land, irrespective of tenure, that has been established as forestry (native or plantation), but can also used be for other purposes such as grazing. Current plantation forestry locations are developed from data from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), HQPlantations Pty Ltd and Forest Enterprises Australia Holdings (FEA Holdings). Current native forestry is based on data from the Department of Agriculture, Fisheries and Forestry (Queensland) and the Department of Environment and Heritage Protection. 'High potential' = higher value commercial timber species of suitable height for sawlog production. 'Medium potential' = commercial species but trees not of sufficient height for sawlog production or no height information available. 'Low potential' = areas with tree cover but not commercially viable species or may include timber species suitable for forest products other than sawlogs.

‡ Agricultural land-use category.

§ MUIDs (management unit inventory data) over leasehold land and reserves generally cover the entire lot on plan, though the actual native forest production area is restricted to the forested area within the lot on plan. Therefore, this figure does not represent the actual area of production.

6.3 Data confidence

The data confidence map (Map 6.17) indicates that the agricultural land-class dataset that was used as the basis for most of the maps developed for the Far North Queensland region was considered a mixture of 'high' along the coastal areas and into the tablelands. The remainder of the region predominantly has 'low' data confidence levels.

The confidence levels indicate how well the line work, soil data and soil quality information provided match reality. They are determined by how spatially accurate the lines around different soil types are on the map, how much information was available for soil data, how soil quality information was collected, what was collected and the skill of those collecting the information.

Most of the current land-use information used in the audit has been obtained through the Queensland Land Use Mapping Program (QLUMP). Land use is determined through available databases, satellite imagery and aerial photographs. As there are difficulties with differentiating land uses using imagery, local expert knowledge and some field surveys have been conducted to verify the data.[33]

The current locations of intensive animal production facilities are derived from data from the Intensive Livestock Environmental Regulation Unit, within the Department of Agriculture, Fisheries and Forestry (Queensland). The areas for intensive land use and location of current aquaculture production are based on QLUMP data. The location of egg producers is based on the Safe Food Queensland egg register as at October 2012.

Current plantation forestry locations are developed from data from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), HQPlantations Pty Ltd and Forest Enterprises Australia Holdings (FEA Holdings).

Apart from forestry and intensive livestock (where more up-to-date and specific datasets are available), QLUMP data represents the best available dataset for the other land uses and was used in the identification of current areas of agricultural production.

The QLUMP forestry data is based on state forest boundaries and some plantation forest information is also included. However, there is also native forestry on private land and other state land (for which state government information is available). There are also more accurate and up-to-date plantation forestry datasets available from ABARES, HQPlantations and FEA Holdings. Therefore, the forestry analysis (which is based on non-QLUMP datasets) is presented in Table 6.3.

As there will be differences between the current Intensive Livestock Environmental Regulation Unit data, forestry information and the QLUMP dataset, the current land-use information based on QLUMP data does not represent exact and current figures for land area (as the data used is 2009 along the coast and tablelands and 1999 for the inland areas), but relative areas between the different land-use types.

Intensive animal operations represent a relatively small agricultural footprint. Therefore, differences in datasets for intensive livestock are not likely to significantly impact on the relative proportions of other land uses.

Grazing can be a mixed land use; therefore, the difference between the total area for forestry from QLUMP data and that derived from the other datasets will largely occur in areas where grazing and forestry are occurring on the same land.

When determining the potential for each of the different land uses, a number of assumptions had to be made (as a result of issues such as uncertainties in the mapping). The net result of these assumptions is that the area figures contained in Table 6.2 overestimate the true potential area for each agricultural land-use category.

33 The methods QLUMP apply to mapping land use are described in full in the ABARES handbook *Guidelines for land use mapping in Australia: principals, procedure and definitions* (4th edition), available at ‹http://adl.brs.gov.au/data/warehouse/pe_abares99001806/GuidelinesLandUseMappingLowRes2011.pdf›.

6.4 Sources of information

6.4.1 Bibliography

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6.4.2 Further studies

Pre-amalgamation shire handbooks

- Douglas Shire (1974)
- Mulgrave Shire (1976)
- Cardwell Shire (1976)
- Mareeba Shire (1978)
- Johnstone Shire (1979)
- Atherton Shire (1975)
- Eacham Shire (1973)
- Herberton Shire (1976)

Studies

The references marked with an * are available to view (or download) from the Department of Environment and Heritage Protection electronic library at www.ehp.qld.gov.au (click on the 'Library catalogue' link).

Use the search function and the title of the reference to access the relevant documents in PDF format.

Note: Some of these documents are very large (up to 50 MB).

Department of Natural Resources and Mines 2012, *Grazing land management land types—wet tropics*, State of Queensland.

Abstract: This includes the spatial representation of Queensland grazing land management (GLM) land types as described by the Department of Employment, Economic Development and Innovation, Queensland. GLM land types are described in terms of their landform, woody vegetation, expected pasture composition (including suitable sown pastures and introduced weeds) and soil characteristics. Limitations to use of the land and grazing management recommendations are also provided. More than 230 land types from 19 GLM regions in Queensland have been described. Updated data is available at ‹http://dds.information.qld.gov.au/dds/›.

Department of Science, Information Technology, Innovation and the Arts 2007, 'Lands of the Leichhardt–Gilbert area, North-West Queensland', CSIRO, *Land Research Series*, no. 11, 1 map.

Abstract: This dataset is a land systems map of the Leichhardt–Gilbert area of north-western Queensland. The area comprises 117 000 square miles (303 029 km^2). This survey was conducted by CSIRO. This data is available through the Queensland Government Information Service website, ‹http://dds.information.qld.gov.au/dds/›.

Galloway, R, Gunn, R & Story, R 1970, 'Lands of the Mitchell–Normanby area, Queensland', CSIRO, *Land Research Series*, no. 26, 101 pp.

Abstract: The Mitchell–Normanby area described in this report occupies the lower two-thirds of the Cape York Peninsula and lies between the 14th and 18th parallels of south latitude. It covers approximately 55 000 square miles (142 449 km^2) and has maximum length and width of about 290 miles (467 km). The western boundary is defined by the coast of the Gulf of Carpentaria and the eastern boundary is partly the Pacific coast and partly the Great Dividing Range, which separates west-flowing and east-flowing drainage. On the south-west it abuts on the Leichhardt–Gilbert area surveyed in 1953–54 (Perry et al. 1964, 'Land systems of the Leichhardt–Gilbert area', in *General report on the lands of the Leichhardt–Gilbert area, Queensland,* pp. 25–36, CSIRO, Melbourne).

***Grundy, MJ & Heiner, IJ 1994, *Soils of Lakeland Downs*, Department of Primary Industries, Queensland, 36 pp.**

Abstract: This project was designed to document the soil and land resources of the basalt lands around the township of Lakeland Downs. This area has become an increasingly important area of rain-fed and irrigated agriculture. Lakeland Downs is a small agricultural region of some 10 000 hectares centred on the basaltic areas of the Maclean Province, some 200 km north-west of Cairns. This project consists of digital data, a report and a published map.

***Grundy, MJ & Reid, RE 1986, *Agricultural land suitability of Herberton Shire*, Department of Primary Industries, Queensland, project report Q086006, 20 pp.**

Abstract: This report presents the findings of a land systems survey of the Herberton Shire Council, where land was mapped into agricultural land suitability classes. The study identified 34 520 hectares of arable land and 158 730 hectares of marginal arable land; the remaining 756 330 hectares was mapped as non-arable. Each grouping was further subdivided due to climate or the nature of limitations. The electronic version has a link to a land suitability map.

***Heiner, IJ & Grundy, MJ 1994, *Land resources of the Ravenshoe – Mt Garnet area, North Queensland: volume 1—land resource inventory*, Department of Primary Industries, Queensland, land resources bulletin: QV94006, 123 pp.**

Abstract: This project describes the land resources of 300 000 hectares of land surrounding the towns of Ravenshoe and Mount Garnet in North Queensland. The specific aims were to map areas of suitable soils, develop a detailed land suitability framework to match crop requirements with soil and land attributes and identify specific hazards and other land management issues. This project consists of two reports, digital data and published maps. The electronic version has a link to a soils map.

***Jamieson, B, Pitt, G & Van den Berg, D 2006, *Land use change mapping from 1999 to 2004 for the Johnstone River catchment, Queensland*, Department of Natural Resources, Mines and Water, Queensland, 18 pp.**

Abstract: The Johnstone River catchment is approximately 235 443 hectares in area and is located in Far North Queensland. The area extends from the Atherton Tableland to the coast as far down as Innisfail. The catchment has undergone significant changes over the past few decades, resulting in approximately 50 per cent of the catchment being cleared for human settlement and agricultural practices. The remainder of the catchment is tropical rainforest listed under the Wet Tropics World Heritage Area. During the initial land-use mapping for the year 1999, a wide diversity of agricultural practices were noted including banana growing, sugarcane growing, dairy farming and livestock grazing (predominantly beef).

***Kent, DJ & Tanzer, JM 1983a, *Evaluation of agricultural land in Eacham Shire, North Queensland*, Department of Primary Industries, Queensland, project report DLUR 83/5, 29 pp.**

Abstract: This is a report on the evaluation of the agricultural resources of Eacham Shire undertaken to identify and map the valuable agricultural land for shire planning purposes. A more recent and alternative report for this area is *Soils and land suitability of the Atherton Tableland*, DNRQ980091, project code TAB.

***Kent, DJ & Tanzer, JM 1983b, *Evaluation of agricultural land in Atherton Shire, North Queensland*, Department of Primary Industries, Queensland, project report DLUR 83/5, 30 pp.**

Abstract: This is a report on the evaluation of the agricultural resources of Atherton Shire undertaken to identify and map the valuable agricultural land for shire planning purposes.

***McClurg, JI, Donnollan, TE & Tucker, RJ 1988, *Soils and land suitability of Mulgrave section, Burdekin River Irrigation Area, part A—summary*, Department of Primary Industries, Queensland, land resources bulletin: QV88004, 58 pp.**

Abstract: This project summarises the results of a 1:25 000 scale soil survey and land suitability assessment of soils and crop suitability in the Mulgrave section, Burdekin River Irrigation Area. It details suitability for growing rice, sugarcane, mangoes, vegetables and grain crops, and provides information on soil quality, types, fertility and development limitations. The electronic version has links to a map of soils, and land suitability maps for rice, mangoes, grain crops, vegetables and sugarcane.

***Malcolm, D, Nagel, B, Sinclair, I & Heiner, IJ 1999, *Soils and agricultural land suitability of the Atherton Tableland, North Queensland*, Department of Natural Resources, Queensland, 241 pp.**

Abstract: The land resources of approximately 160 000 hectares of the Atherton Tableland, North Queensland, were surveyed at a medium intensity scale of 1:50 000. Soils were mapped according to their geological parent material and topographical position. The climate of the area is predominantly humid subtropical with the majority of rain falling in the summer. Five climatic zones have been identified across the survey area. Over 2000 site descriptions were made identifying 34 different soil profile classes. All major soils were sampled for chemical analysis. Morphological and physical soil properties pertinent to the assessment of land suitability for agriculture were also recorded.

***Manders, J, O'Brien, L & Morrison, D 2009, *Acid sulfate soils of Cairns, North Queensland*, Department of Environment and Resource Management, Queensland, 47 pp. plus CD.**

Abstract: Of the 14 337 hectares investigated, 459 hectares were found to contain actual acid sulfate soils with existing acidity up to 0.31 per cent sulfur (equivalent) at shallow depth (the top 0.5 m). Of the remaining 8847 hectares, potential acid sulfate soils only were found, with up to 6.7 per cent sulfur at various depths ranging from the surface to greater than 15 m below the surface. These results indicate the need for caution in planning and managing developments in the Cairns area to avoid costly damage to the environment, human health and local infrastructure. Additional investigation will be required prior to construction or excavation to satisfy the recommendations of the *Sampling guidelines* (Ahern et al. 1998) and State Planning Policy 2/02.

***Pitt, G 2007, *Land use change mapping from 1999 to 2004 for the Tully River catchment*, Department of Natural Resources and Water, Queensland, 21 pp.**

Abstract: The Tully River catchment is approximately 168 583 hectares in area and is located in Far North Queensland. The catchment area extends from the south-east corner of the Evelyn Tableland down the Kirrama Range along the floodplain to the coast south of Tully River and up to Mission Beach. The catchment underwent significant clearing in the early half of this century and now approximately 24 per cent of the catchment use is rural residential, urban development and agriculture. The remainder of the catchment, approximately 76 per cent, is made up of natural environments such as tropical rainforest, mangroves, wetlands and water bodies. Approximately 65 per cent of the catchment is part of the Wet Tropics World Heritage Area. Koombooloomba Dam is located on the upper reaches of the Tully River and was constructed for hydroelectric power generation. The Tully River is also used by tourism operators conducting white-water rafting activities. During the initial land-use mapping for 1999, a wide diversity of agricultural practices were noted including sugarcane growing, banana growing, grazing (predominantly beef cattle) and cattle fattening.

***Roebeling, PC & Webster, AJ 2007, *Review of current and future best management practices for sugarcane, horticulture, grazing and forestry industries in the Tully–Murray catchment—a report to FNQ NRM Ltd*, CSIRO, 64 pp.**

Abstract: This study compiled and assessed water quality outcomes of current and future (potential) best management practices for sugarcane, horticulture, grazing and forestry production systems, based on a desktop study, industry and expert feedback, and experience from the Douglas Shire Water Quality Improvement Plan. It reviewed current and future best management practices for sugarcane, horticulture, grazing and forestry production systems. Also, it gathered industry and expert feedback on several aspects of current and future best management practices for sugarcane, horticulture, grazing and forestry production systems, and provided a basis for research prioritisation of best management practices that have the largest potential to contribute to water quality improvement in the Tully–Murray catchment.

***Wilson, PR & Seonaid, P 1999, *An assessment of agricultural potential of soils in the Gulf region, North Queensland*, Department of Natural Resources, Queensland, 66 pp.**

Abstract: This detailed study maps land suitability for a wide range of crops including peanuts, bananas, tree crops and rice The Gulf study area covers the catchments of the Mitchell, Gilbert, Etheridge, Einasleigh, Norman, Flinders, Leichhardt, Albert, Nicholson and Gregory rivers as defined in the WIP/DIP Gulf region study definition statement. The area is within the local government shires of Richmond, Burke, Carpentaria, Croydon, Etheridge and Mareeba. The study area lies between the Gulf of Carpentaria and 22° S latitude, and between 138° and 145° E longitude.

***Wilson, PR & Steel, RJH 1988, *North Queensland tea land suitability study*, Department of Primary Industries, Queensland, land resources bulletin: QB88006, 62 pp.**

Abstract: Land resources of the Hinchinbrook, Cardwell, Johnstone, Mulgrave, Douglas, Eacham and Atherton shires were examined in terms of climate, soils and landform to assess their suitability for growing tea. Six hundred unique map areas (UMAs) were individually assessed using a land suitability classification scheme. Four maps at a scale of 1:100 000 accompany the electronic version of this report and show land suitability for tea. The study indicates that there are 63 169 hectares suitable for growing tea. There are 39 620 hectares of land suitable with negligible to minor limitations (classes 1 and 2) and 23 549 hectares with moderate limitations (class 3).

Map 6.2 Water resources

This map provides an overview of current water resources and water infrastructure.

Far North Queensland — Water resource planning

143°0'0"E 144°0'0"E 145°0'0"E 146°0'0"E

16°0'0"S 17°0'0"S 18°0'0"S

Legend

- Towns
- Weirs & Dams
- Rivers
- Far North Queensland region
- Water supply scheme
- Irrigation areas
- Subartesian water areas
- Groundwater management areas (GMA)
- Water resource plan areas

N

0 20 40 80
km

Datum: GDA 94 Projection: Geographic
Page size: A4

Locality Map
Queensland regional planning boundaries

Palmer River
Mitchell River
Daintree River
Mossman River
Staaten River
Walsh River
Lynd River
Pelican Creek
Echo Creek
Einasleigh River
Gilbert River
Barron River
Eureka Creek
Emu Creek
Barron River
Mulgrave River
Russell River
Johnstone River
Liverpool Creek
Wild River
Tully River
Rudd Creek
Herbert River
Murray River

Highbury
Gamboola
Daintree
Mossman
Port Douglas
Mount Carbine
Julatten
Mount Molloy
Chillagoe
Almaden
Dimbulah
Atherton
Malanda
Herberton
Gordonvale
CAIRNS
INNISFAIL
Ravenshoe
Mount Garnet
Tully
Cardwell

Mareeba Weir
Emerald Weir
Copperlode Falls Dam
Granite Creek Weir
Dulbil Weir
Bruce Weir
Leafgold Weir
Solanum Weir
Collins Weir
Tinaroo Falls Dam
Herberton Town Weir
Wyndham Tailings Dam
Koombooloomba Dam

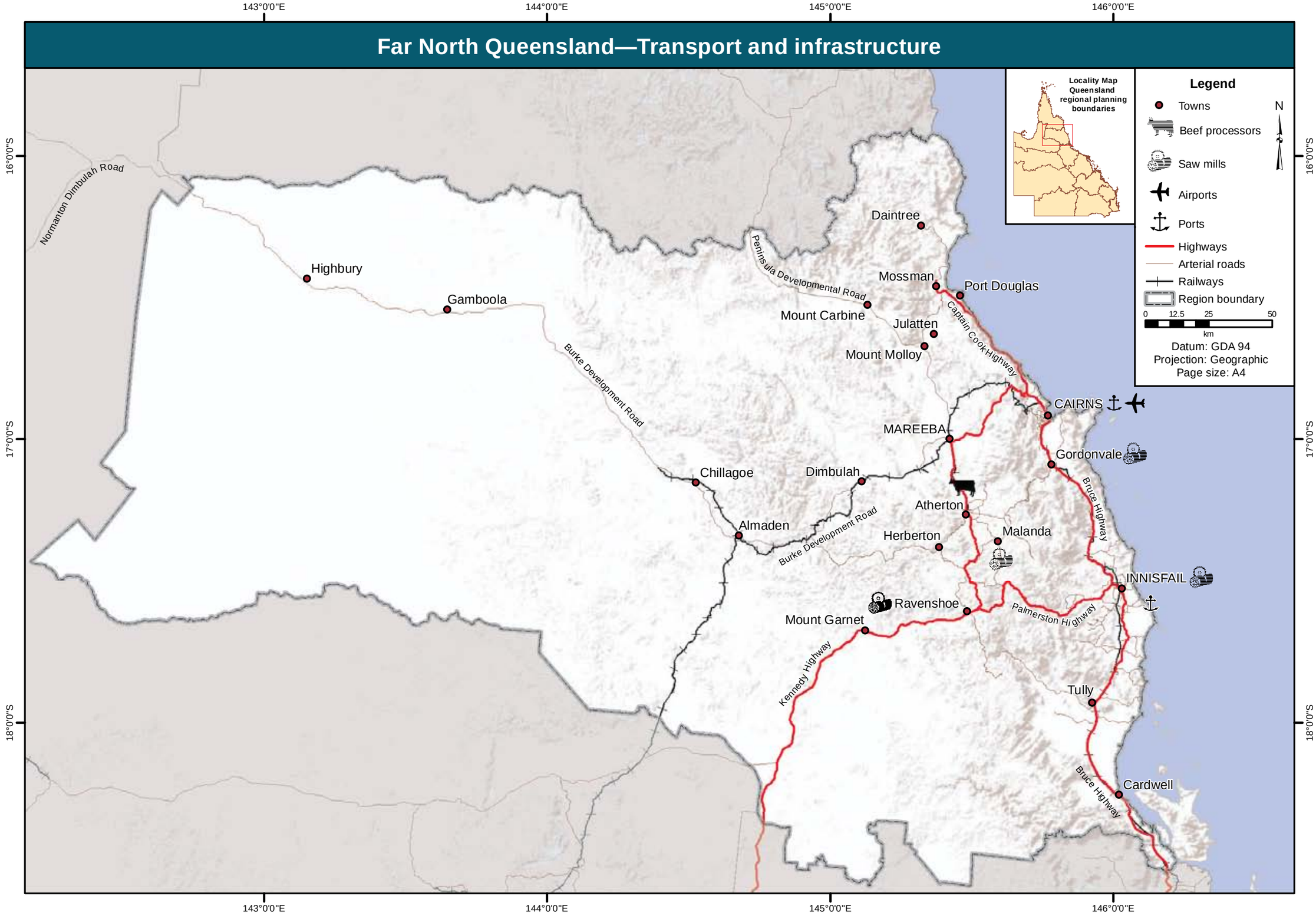
Mitchell
Gulf
Chillagoe GMA
Barron
Burdekin
Mossman GMA
Cairns Northern Beaches GMA
Cairns Coast GMA

Great Artesian Basin (subartesian water area)

Map 6.3 Infrastructure

This map shows key infrastructure components, major agricultural processing plants and natural features relevant to current and future agricultural development within the region.

Far North Queensland—Transport and infrastructure



Map 6.4 Vegetation management

This map shows land where, based on currently available information, agricultural use is potentially impacted by the provisions of the *Vegetation Management Act 1999* or associated Regulations protecting native vegetation. It has been compiled from information available to the audit at 28 September 2012 and reflects the legislative and policy regime in place at that time. The map shows areas where no clearing is permitted and areas where clearing requires further verification.

'Clearing requires further verification' can be split into two categories. Category A is where clearing for agriculture purposes may be constrained to varying levels under the Vegetation Management Act. These areas need further verification on the ground, depending on the types of activities taking place. Land that is category A has been denoted:

- high-value regrowth

or

- Schedule 4 Grassland regional ecosystem—homogeneous or heterogeneous polygons

or

- Schedule 5 Grasslands—heterogeneous polygons.

Category B indicates land for which regional ecosystems have not been reliably mapped. This land may or may not contain areas of regional ecosystems where clearing for agricultural purposes is constrained under the Vegetation Management Act. This land requires regional ecosystem mapping before its status can be confirmed. Land that is in this category has been denoted remnant vegetation on the 'remnant map' as per the description on the Department of Environment and Heritage Protection website at www.ehp.qld.gov.au (search 'remnant vegetation').

'No clearing permitted' identifies land for which clearing for agriculture purposes is constrained under the Vegetation Management Act. This land has been denoted:

- remnant vegetation other than Schedule 4 Grasslands on the regional ecosystem map

and

- category A or B on a PMAV.

Far North Queensland Restrictions on clearing based on the Vegetation Management Act (1999)

Uncoloured areas within region are already cleared or have no restrictions to clearing

Legend

- No clearing permitted
- Clearing requires further verification
- National parks and state forests
- Region boundary
- Roads
- Rivers
- Towns

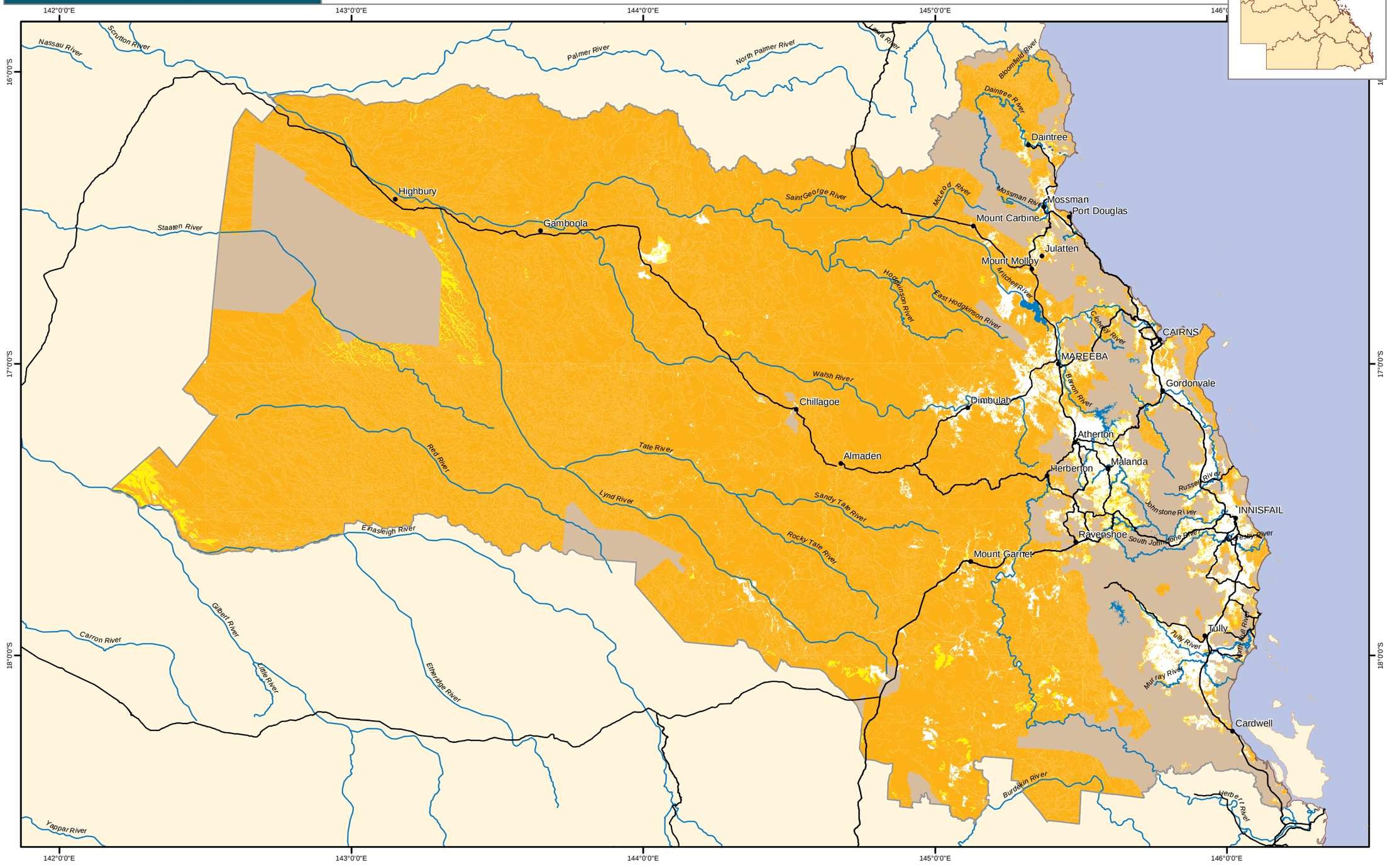
N

1:1,300,000

0 10 20 40 60 80 km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map Queensland regional planning boundaries



Map 6.5 Current land use

This map shows the extent and distribution of land used for each of the agricultural land-use classes adopted by the audit. It has been produced mainly using data collected by QLUMP. QLUMP mapping has been generated using a combination of satellite image interpretation and ground validation. Its nominal scale is 1:100 000 and for this region it is current as at 1999 for western areas and 2009 for coastal and tableland areas. Visit www.derm.qld.gov.au (search 'QLUMP') for further information about QLUMP. Forestry plantations are mapped using data provided by ABARES and HQPlantations and state forest boundaries have been extracted from the Queensland Government tenure spatial layer.

Far North Queensland
Current land use based on QLUMP data (2009 along the coast and Tablelands, 1999 to the west) and other data sources for forestry (see explanatory notes)

Legend

- Current forestry plantations
- State forests
- Annual horticulture
- Perennial horticulture
- Cropping
- Irrigated cropping
- Grazing
- Intensive animal production
- Sugarcane
- Defence
- Nature conservation
- Mining
- Water
- Other land use
- Region boundary
- Roads
- Rivers
- Towns

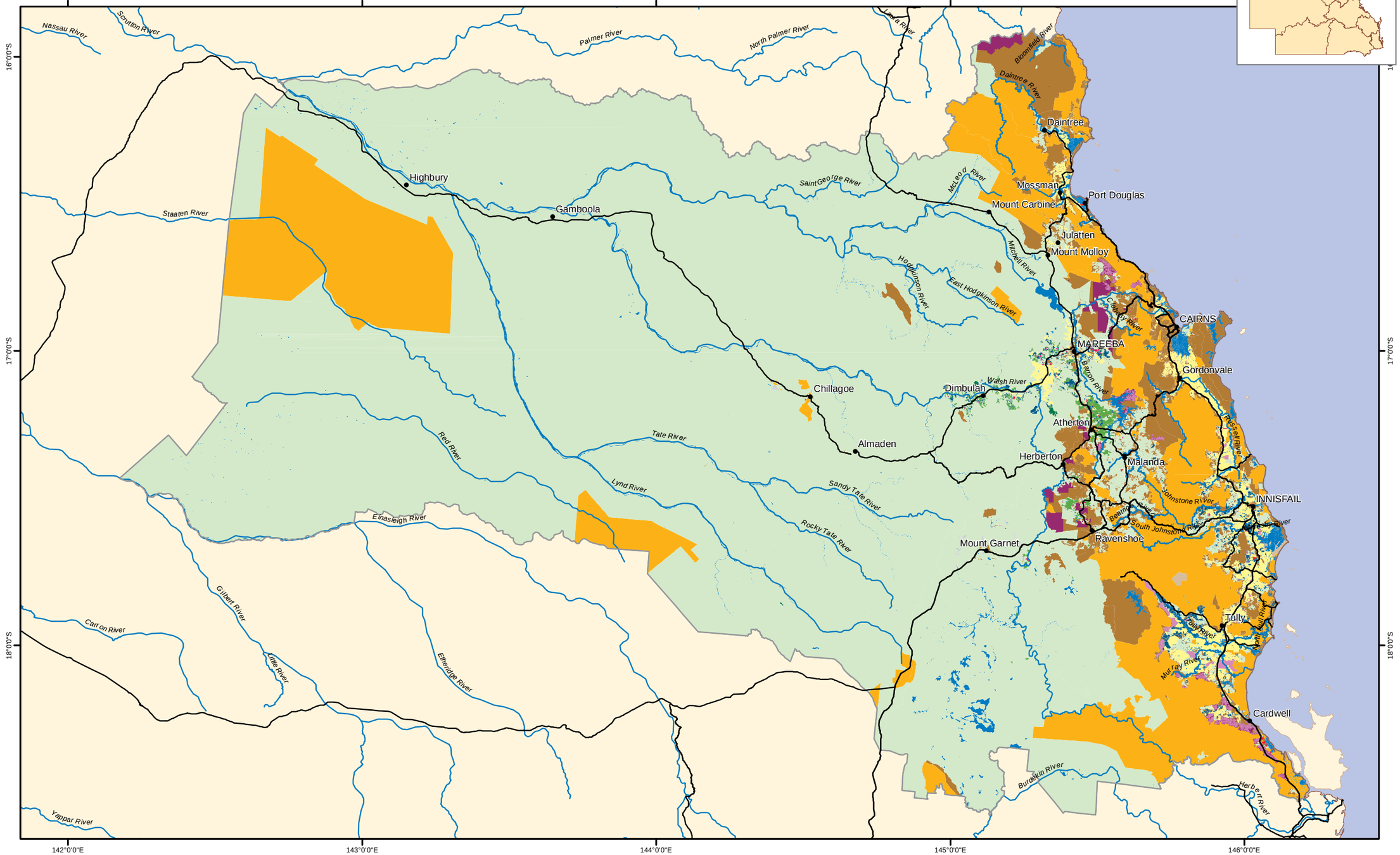
N

1:1,300,000

0 5 10 20 30 40 km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map Queensland regional planning boundaries



Map 6.6 Important agricultural areas

This map shows the important agricultural areas identified by the audit within this region. An area is identified by the audit as being important for agriculture if it has all the requirements for agriculture to be successful and sustainable, is part of a critical mass of land with similar characteristics and is strategically significant to the region or the state. The areas shown on this map have been identified by the audit on the basis of advice from regional and industry experts and from synthesis of maps and information on current and potential use of land for the range of agricultural land uses considered by the audit. The information used to derive this map varies in its spatial accuracy and resolution. In recognition of these limitations, the information has been generalised for use in strategic decision-making at the regional level. It is indicative only of broad areas within which land important for agriculture is located. More detailed investigation to map the spatial extent and location of important land would be required before the information is suitable for finer scale decision-making such as in statutory land-use planning.

Far North Queensland
Important agricultural land areas

Legend

- Mareeba Dimbulah irrigation area
- Atherton Tablelands
- Southern Coastal area
- Areas excluded from potential (see explanatory notes)
- Region boundary
- Roads
- Rivers
- Towns

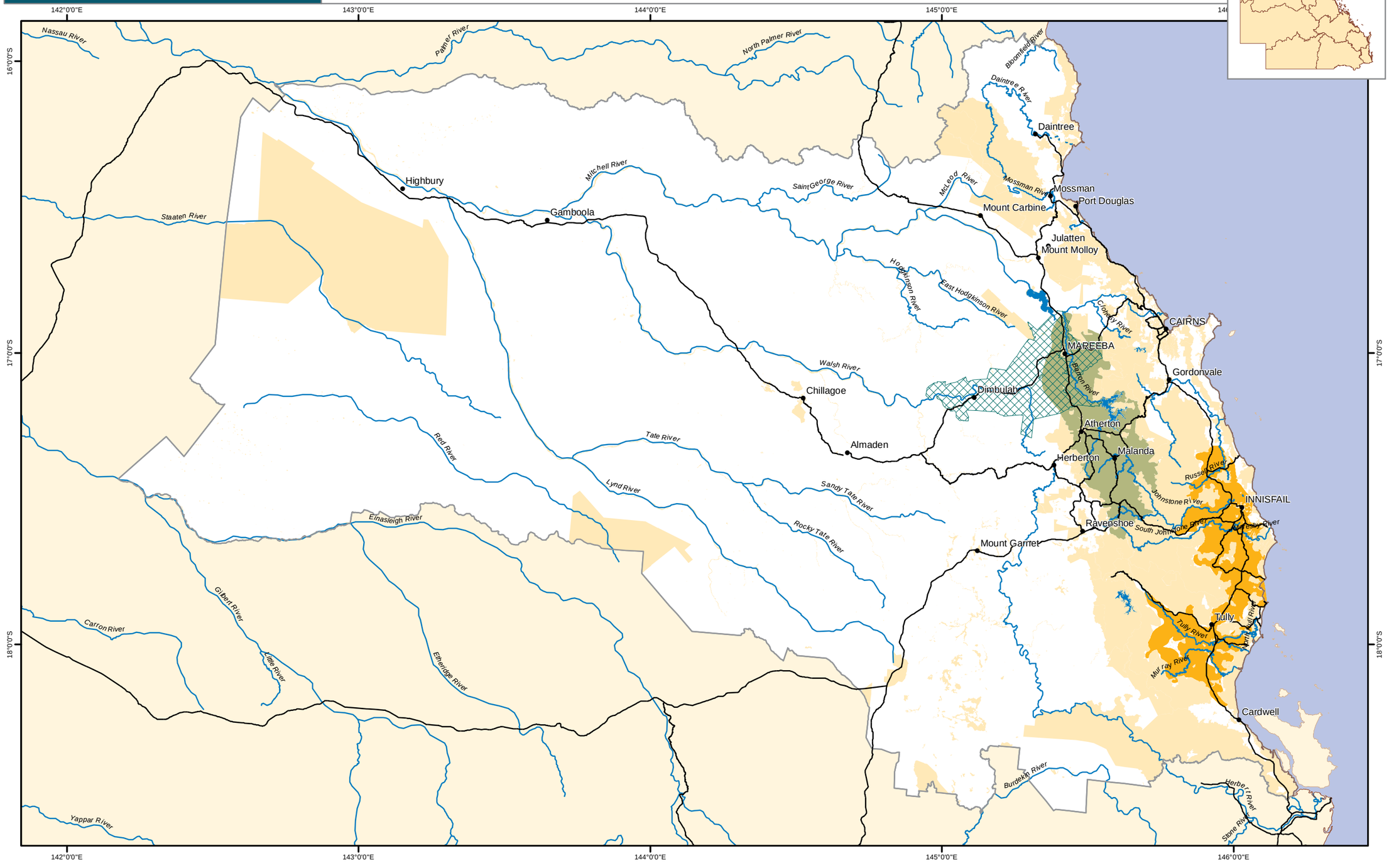
N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 6.7 Broadacre cropping

This map shows land identified by the audit as currently being used for the agricultural land-use category 'broadacre cropping' (rain-fed or irrigated). It also shows land identified as not currently used for broadacre cropping but having potential to be used for this purpose. Land shown as currently being used for broadacre cropping has been identified on the basis that it was mapped by QLUMP as secondary class 'cropping' or 'irrigated cropping'.

Land shown as having potential for broadacre cropping:

a) **includes** land of agricultural land class (ALC) A with slope less than 8 per cent and mean annual rainfall greater than 450 mm for 7 out of 10 years

b) **excludes** land that is urban, intensive use (such as mining), national park, state forest, managed by the Department of Defence or permanently under water.

In identifying this land, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses and competing potential land uses) that are important influences on management decisions made by producers who drive land use.

It should not be assumed from this study that all (or any particular portion of) land identified as having potential to be used for broadacre cropping should or will be converted to that use. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by constraints that have not been included as criteria in the mapping, for example the availability of water for irrigation (see Map 6.2). See Section 6.1 for further constraints.

Far North Queensland
Biophysical potential for broadacre cropping and current broadacre cropping

Potential based on ALC 'A', slope <8%,
rainfall >450mm 7 in 10 years

Legend

- Potential broadacre cropping
- Current cropping
- Current irrigated cropping
- Areas excluded from potential (see explanatory notes)
- ALC data gaps
- Region boundary
- Roads
- Rivers
- Towns

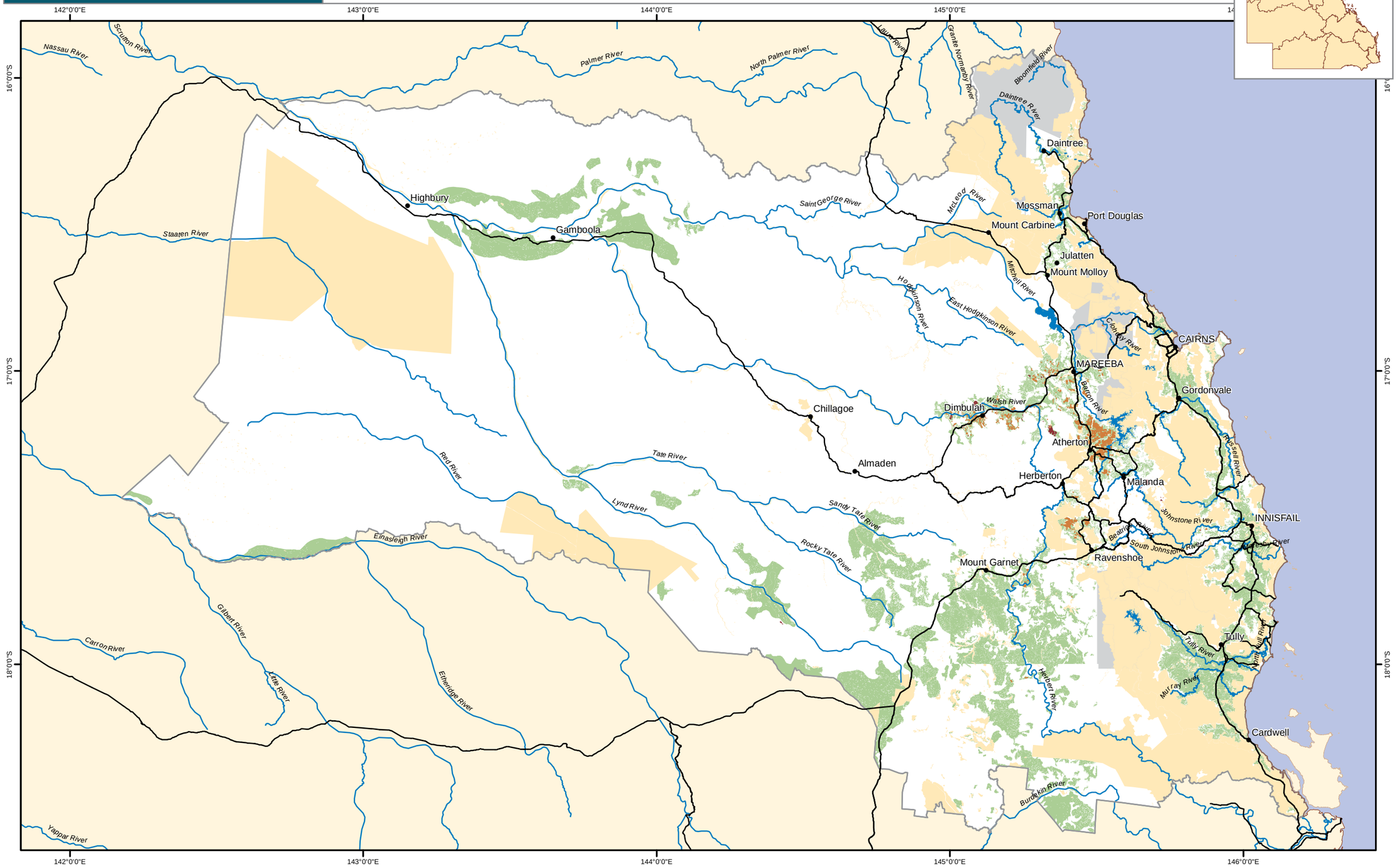
N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 6.8 Sugarcane

This map shows land identified as not currently used for sugarcane cultivation but having potential to be used for this purpose. Land shown as currently being used for sugarcane cultivation has been identified on the basis that it was mapped by QLUMP as tertiary class 'sugarcane'.

Land shown as having potential for sugarcane cultivation:

a) **includes** land of agricultural land class A and class B with slope less than 5 per cent and fewer than 55 days per year with a minimum temperature of 9 °C or less

b) **excludes** land that is urban, intensive use (such as mining), national park, state forest, managed by the Department of Defence or permanently under water.

In identifying this land, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses and competing potential land uses) that are important influences on management decisions made by producers who drive land use. These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

Access to a sugar mill is an important consideration in determining the potential for land to be used for growing sugarcane. The locations of current mills are shown on the map for information.

It should not be assumed from this study that all (or any particular portion of) land identified as having potential to be used for sugarcane cultivation should or will be converted to that use. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by constraints that have not been included as criteria in the mapping, for example the availability of water for irrigation (see Map 6.2). See Section 6.1 for further constraints.

Far North Queensland Biophysical potential for sugarcane and current sugarcane

Potential based on ALC 'A' and 'B', slope <5%, <55 days per year where minimum temperature ≤9˚C

Legend

- Potential sugarcane
- Current sugarcane production
- Areas excluded from potential (see explanatory notes)
- ALC data gaps
- Region boundary
- Sugar mills
- Sugarcane rail
- Roads
- Rivers
- Towns

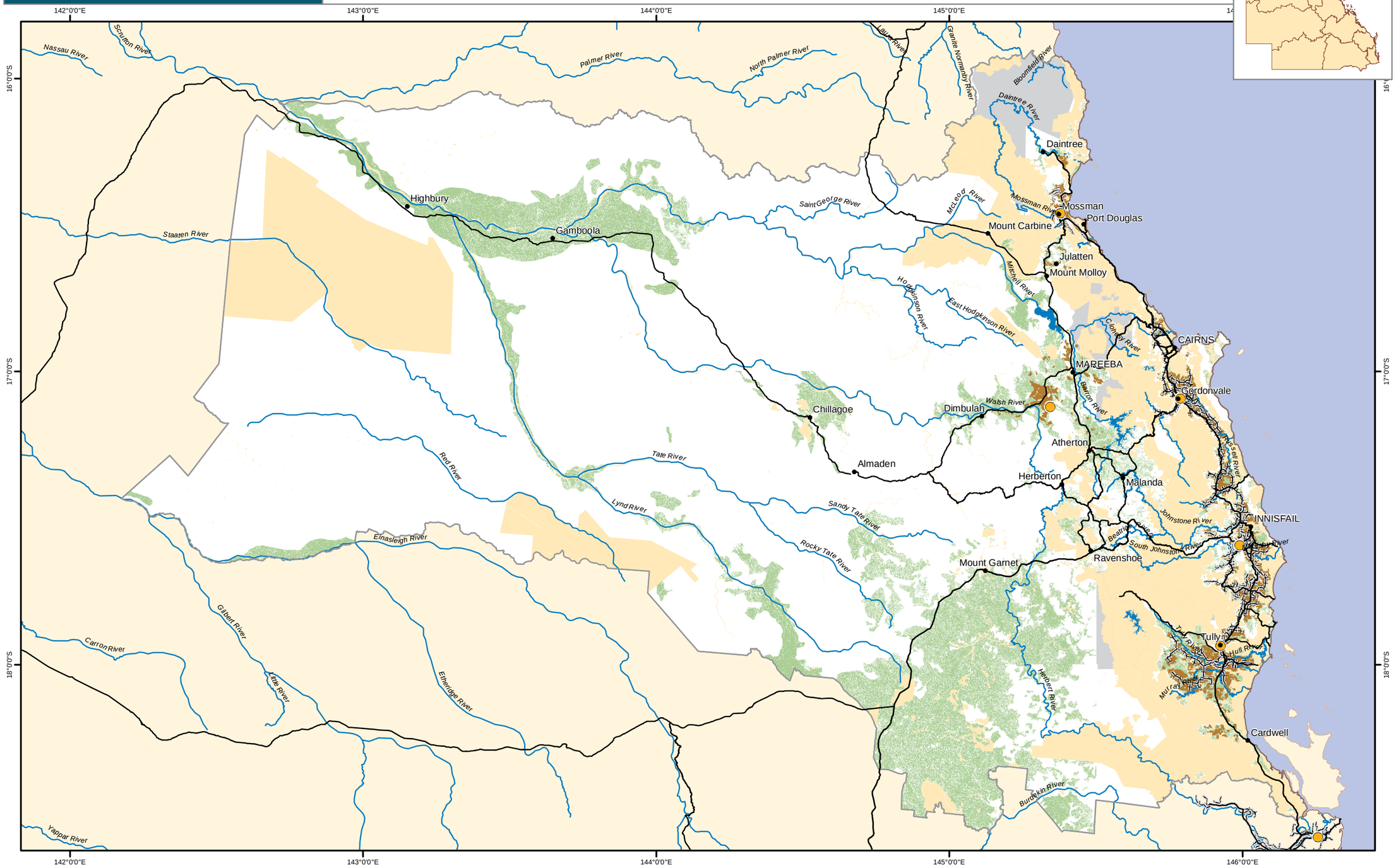
N

1:1,300,000

0 10 20 40 60 80 km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map Queensland regional planning boundaries



Map 6.9 Annual horticulture

This map shows land identified by the audit as currently being used for the agricultural land-use category 'annual horticulture'. It also shows land identified as not currently used for annual horticulture but having potential to be used for this purpose. Land shown as currently being used for annual horticulture has been identified on the basis that it was mapped by QLUMP as 'seasonal horticulture', 'irrigated seasonal horticulture' or 'intensive horticulture'.

Land shown as having potential for annual horticulture:

a) **includes** land of agricultural land class A and class B with slope less than 8 per cent and April to October rainfall less than 500 mm

b) **excludes** land that is urban, intensive use (such as mining), national park, state forest, managed by the Department of Defence or permanently under water.

In identifying this land, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses and competing potential land uses) that are important influences on management decisions made by producers who drive land use. These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

Also, the audit **did not consider** temperature or flood risk. Temperature is a major determinant of suitability of land for horticulture. It affects whether a crop can grow and its performance. However, due to the large range of different horticultural crops grown in Queensland and the widely variable temperature requirements for these crops, it is not possible to determine meaningful criteria for temperature for the category 'annual horticulture'. Flood risk is similarly difficult to map. Reliable data on flood frequency and severity currently exists for comparatively few parts of the state and the extent to which agricultural land use and management are affected by flooding varies greatly from farmer to farmer depending on their individual circumstances and perceptions.

Availability of labour, especially during harvest season, is an important consideration in selecting suitable land for many forms of annual horticulture. To reflect this, areas that are within 50 km of a centre with a population of 2000 or more are highlighted on the map. However, labour is not always a critical factor (e.g. for crops that are mechanically harvested) and the size and proximity of the nearest population centre is not always the best surrogate for labour force availability (e.g. many horticultural businesses make extensive use of itinerant seasonal workers or backpackers).

It should not be assumed from this study that all (or any particular portion of) land identified as having potential to be used for annual horticulture should or will be converted to that use. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by constraints that have not been included as criteria in the mapping, for example the availability of water for irrigation (see Map 6.2). See Section 6.1 for further constraints.

Far North Queensland
Biophysical potential for annual horticulture and current annual horticulture

Potential based on ALC 'A' and 'B', slope <8%,
April - October rainfall <500mm

Legend

- Potential annual horticulture
- Current annual horticulture (not to scale)
- Areas excluded from potential (see explanatory notes)
- ALC data gaps
- Region boundary
- 50km from a population >2000
- Roads
- Rivers
- Towns

N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries

142°0'0"E 143°0'0"E 144°0'0"E 145°0'0"E 146°

16°0'0"S 17°0'0"S 18°0'0"S

Nassau River
Scruton River
Palmer River
North Palmer River
Laura River
Granite Normanby River
Bloomfield River
Daintree River
Daintree
Highbury
Gamboola
Staaten River
Saint George River
McLeod River
Mossman River
Mossman
Port Douglas
Mount Carbine
Julatten
Mount Molloy
Mitchell River
Hodgkinson River
East Hodgkinson River
Clohesy River
CAIRNS
MAREEBA
Barron River
Gordonvale
Walsh River
Chillagoe
Dimbulah
Atherton
Almaden
Malanda
Herberton
Russell River
Johnstone River
INNISFAIL
Ravenshoe
South Johnstone River
Liverpool River
Mount Garnet
Tully
Tully River
Hull River
Murray River
Cardwell
Red River
Tate River
Lynd River
Sandy Tate River
Rocky Tate River
Einasleigh River
Gilbert River
Carron River
Little River
Etheridge River
Burdekin River
Herbert River
Yappar River

Map 6.10 Perennial horticulture

This map shows land identified by the audit as currently being used for the agricultural land-use category 'perennial horticulture' (rain-fed or irrigated). It also shows land identified as not currently used for perennial horticulture but having potential to be used for that purpose. Land shown as currently being used for perennial horticulture has been identified on the basis that it was mapped by QLUMP as 'perennial horticulture' or 'irrigated perennial horticulture'.

Land shown as having potential for perennial horticulture:

a) **includes** land of agricultural land class A and class B with slope less than 15 per cent and April to October rainfall less than 500 mm

b) **excludes** land that is urban, intensive use (such as mining), national park, state forest, managed by the Department of Defence or permanently under water and land that has cracking clay soils.

In identifying this land, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses and competing potential land uses) that are important influences on management decisions made by producers who drive land use These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

Also, the audit **did not consider** temperature or flood risk. Temperature is a major determinant of suitability of land for horticulture. It affects whether a crop can grow and its performance. However, due to the large range of different horticultural crops grown in Queensland and the widely variable temperature requirements for these crops, it is not possible to determine meaningful criteria for temperature for the category 'perennial horticulture'. In addition, the inability to map microclimates at the appropriate scale means that temperature cannot be included in the criteria. Flood risk is similarly difficult to map. Reliable data on flood frequency and severity currently exists for comparatively few parts of the state and the extent to which agricultural land use and management are affected by flooding varies greatly from farmer to farmer depending on their individual circumstances and perceptions.

Availability of labour, especially during harvest season, is an important consideration in selecting suitable land for many forms of perennial horticulture. To reflect this, areas that are within 50 km of a centre with a population of 2000 or more are highlighted on the map. However, labour is not always a critical factor (e.g. for crops that are mechanically harvested) and the size and proximity of the nearest population centre is not always the best surrogate for labour force availability (e.g. many horticultural businesses make extensive use of itinerant seasonal workers or backpackers).

It should not be assumed from this study that all (or any particular portion of) land identified as having potential to be used for perennial horticulture will be converted to that use. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by constraints that have not been included as criteria in the mapping, for example the availability of water for irrigation (see Map 6.2). See Section 6.1 for further constraints.

Far North Queensland
Biophysical potential for perennial horticulture and current perennial horticulture

Potential based on ALC 'A' and 'B', slope <15%, April - October rainfall <500mm, no cracking clays

Legend

- Potential perennial horticulture
- Current perennial horticulture (not to scale)
- Areas excluded from potential (see explanatory notes)
- ALC data gaps
- Region boundary
- 50km from a population >2000
- Roads
- Rivers
- Towns

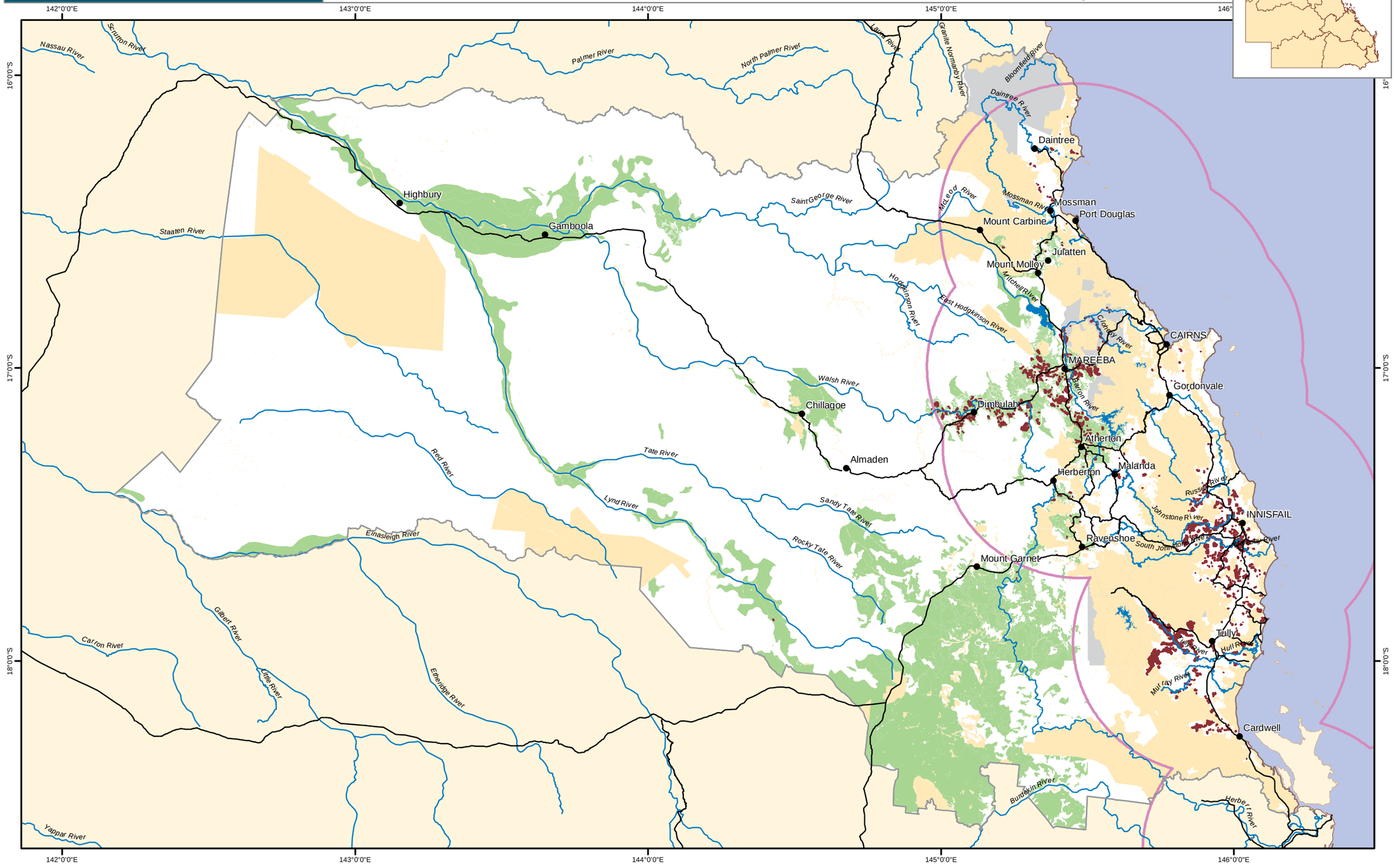
N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 6.11 Intensive livestock

This map shows land identified by the audit as currently being used for the agricultural land-use category 'intensive animal industries' (feedlot cattle and pigs). It also shows land identified as not currently being used for intensive animal industries but having potential to be used for that purpose. Land shown as currently being used for intensive animal industries has been identified on the basis that it is listed in the database of the Department of Agriculture, Fisheries and Forestry (Queensland) Intensive Livestock Environmental Regulation Unit. Cattle feedlots are only included where they have a capacity greater than 150 head. Individual intensive animal enterprises are smaller in area than enterprises involved in other agricultural land-use categories and most intensive animal enterprises would not be visible when represented to scale on audit maps. Because of this, the spatial extent of each current intensive animal enterprise is not shown; instead, each enterprise is mapped using a symbol centred on the centroid of the property.

Major beef abattoirs are shown on the map for information. Their locations have not been used in the analysis to identify land with potential for intensive beef industries as the location of many other smaller-scale abattoirs or country butchers that process animals was not available and therefore it could not be determined where access to processing was a constraint on potential intensive animal production.

Land shown as having potential for intensive animal industries:

a) **includes** land of agricultural land class A and class B (and class C1 where it is within 10 km of current cropping) with slope less than or equal to 8 per cent

b) **excludes** land that is urban, intensive use (such as mining), national park, state forest, managed by the Department of Defence or permanently under water.

In identifying this land, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses and competing potential land uses) that are important influences on management decisions made by producers who drive land use. These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

It should not be assumed from this study that all (or any particular portion of) land identified as having potential to be used for intensive animal industries should or will be converted to that use. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by constraints that have not been included as criteria in the mapping, for example the availability of water (see Map 6.2) and natural resource regulations such as those for vegetation management.

Aquaculture—current and potential

This map shows land identified by the audit as currently being used for the agricultural land-use category 'aquaculture'. It also shows land identified as not currently used for aquaculture but having potential to be used for that purpose. Land shown as currently being used for aquaculture has been identified on the basis that it was mapped by QLUMP as the tertiary class 'aquaculture'. Individual aquaculture enterprises are smaller in area than enterprises involved in other agricultural land-use categories and most aquaculture enterprises would not be visible when represented to scale on audit maps. Because of this, the spatial extent of each current aquaculture enterprise is not shown; instead, each enterprise is mapped using a symbol centred on the centroid of the property.

Land shown as having potential for aquaculture:

a) **includes** land that is within 2 km of an estuarine water source, is above the highest astronomical tide and has an elevation less than 10 m, slope less than 5 per cent and clay content greater than 20 per cent

b) **excludes** land that is urban, intensive use (such as mining), national park, state forest, managed by the Department of Defence, permanently under water, fish habitat area, of high ecological significance or mapped as containing acid sulfate soils.

In identifying this land, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses and competing potential land uses) that are important influences on management decisions made by producers who drive land use. These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

The map also shows areas where there are vulnerable groundwater systems. Contamination of groundwater systems is an important consideration in selecting sites for aquaculture enterprises. However, mapping of groundwater vulnerability in Queensland is relatively coarse and a range of measures can be used to mitigate this risk. Therefore the occurrence of vulnerable groundwater is not included in the criteria for mapping potential for aquaculture but is shown on the map for information.

It should not be assumed from this study that all (or any particular portion of) land identified as having potential to be used for aquaculture should or will be converted to that use. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by constraints that have not been included as criteria in the mapping, for example the availability of water for irrigation (see Map 6.2). See Section 6.1 for further constraints.

Far North Queensland–Biophysical potential for cattle feedlots, piggeries and marine aquaculture and current intensive animal production and aquaculture

Feedlots and piggeries potential: 'A' + 'B' class land + 'C1' class land within 10km of current cropping, slope ≤8%
Marine aquaculture potential: within 2km of estuarine water source, above HAT, <10m elevation, soil >20% clay content

Legend

- Potential feedlot and piggeries area
- Beef processors
- Current cattle feedlots (above 150 head)
- Current egg producers
- Current piggeries
- Potential marine aquaculture area
- Current aquaculture sites
- Areas excluded from potential (see explanatory notes)
- ALC data gaps
- Region boundary
- Roads
- Rivers
- Towns

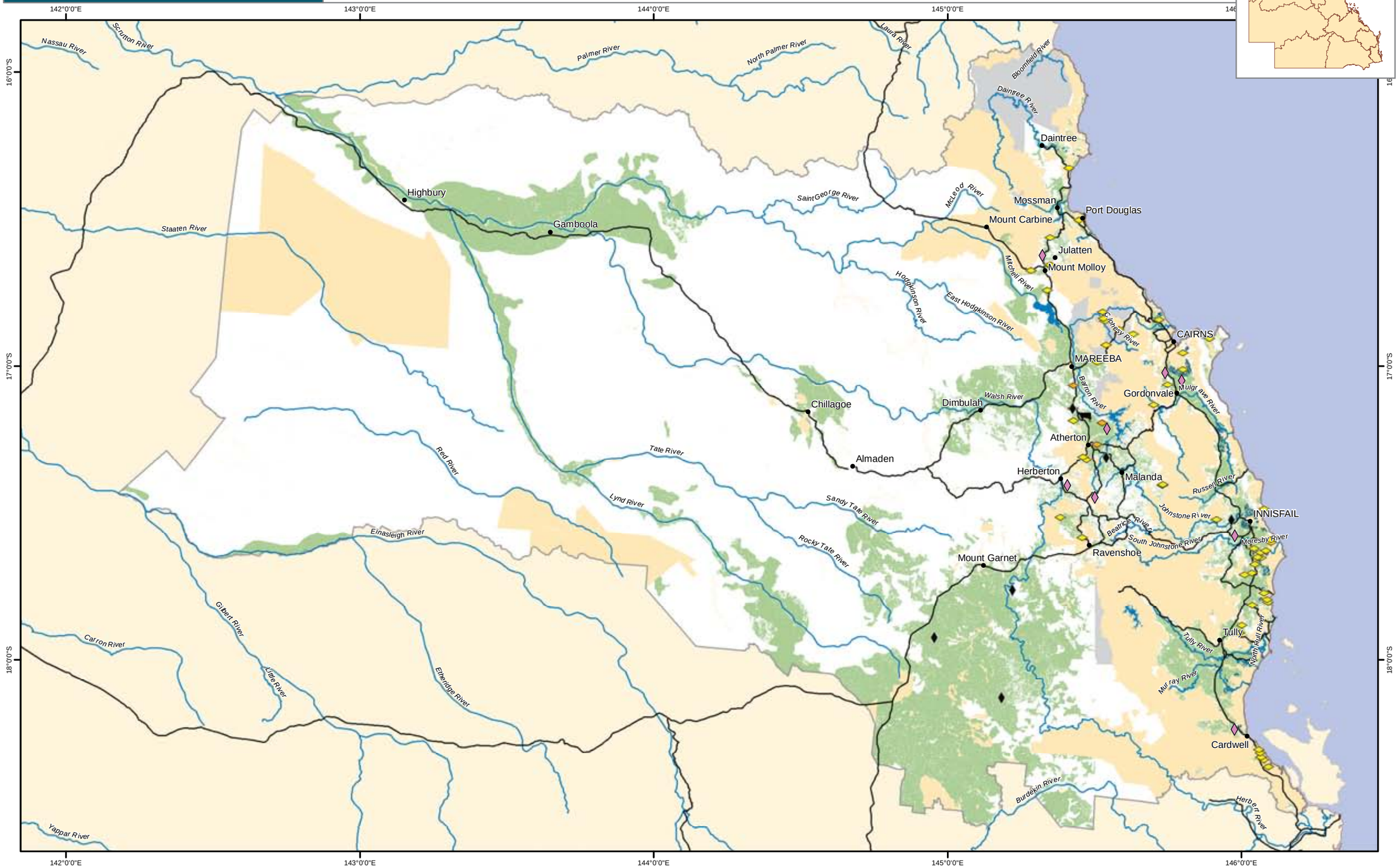
N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map Queensland regional planning boundaries



Map 6.12 Current pasture production (land condition B)

This map shows the current pasture biomass production that was modelled by the audit. For the purpose of this modelling, the land was assumed to be in fair condition (grazing land management (GLM) class B).

Current modelled pasture biomass production of land:

a) is **calculated** using the GRASP model of pasture biomass production (www.longpaddock.qld.gov.au—search 'GRASP') parameterised for each GLM land type (http://futurebeef.com.au) and discounted according to the amount of existing tree basal area on the land (as mapped by SLATS) and with pasture condition set to B (http://futurebeef.com.au)

b) **excludes** production from land that is urban, intensive use (such as mining), national park, managed by the Department of Defence or permanently under water.

In modelling this production, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses or competing potential land uses) that are important influences on management decisions made by producers who drive land use. These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

It should not be assumed from this study that the current modelled pasture biomass production of all land (or any particular portion of land) will be achieved. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by natural resource regulations such as those for vegetation management.

Far North Queensland
Current yearly pasture production (long term average)

GRASP model, modified by tree basal area and land condition (B)

Legend

Yearly pasture production (long term average)
(Dry matter yearly growth in kg/ha)

- High >3500
- Medium 1500-3500
- Low <1500

Areas excluded from potential (see explanatory notes)

Region boundary

Roads

Rivers

Towns

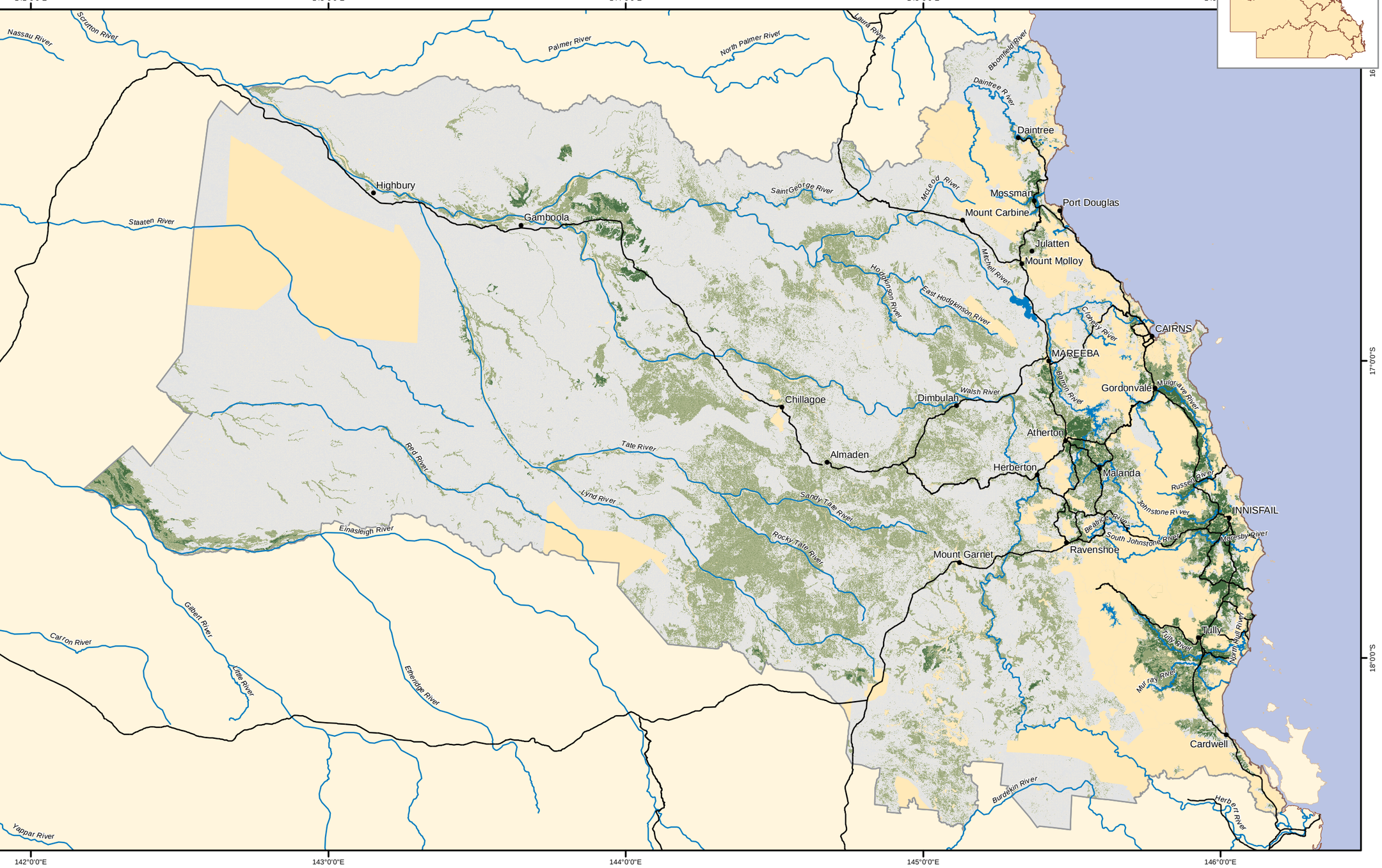
N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 6.13 Potential pasture production (land condition A)

This map shows the potential pasture biomass production that was modelled by the audit. For the purpose of this modelling, the land was assumed to be in good condition (GLM class A).

Potential modelled pasture biomass production of land:

a) is **calculated** using the GRASP model of pasture biomass production (www.longpaddock.qld.gov.au—search 'GRASP') paramaterised for each GLM land type (http://futurebeef.com.au) and discounted according to the amount of existing tree basal area on the land (as mapped by SLATS) and with pasture condition set to A (http://futurebeef.com.au)

b) **excludes** production from land that is urban, intensive use (such as mining), national park, managed by the Department of Defence or permanently under water.

In modelling this production, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses and competing potential land uses) that are important influences on management decisions made by producers who drive land use. These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

It should not be assumed from this study that the potential modelled pasture biomass production of all land (or any particular portion of land) will be achieved. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by natural resource regulations such as vegetation management.

Far North Queensland
Potential yearly pasture production
(long term average)

GRASP model, modified by
tree basal area and land condition (A)

Legend

Yearly pasture production (long term average)
(Dry matter yearly growth in kg/ha)

- High >3500
- Medium 1500-3500
- Low <1500

- Areas excluded from potential (see explanatory notes)
- Region boundary

- Roads
- Rivers
- Towns

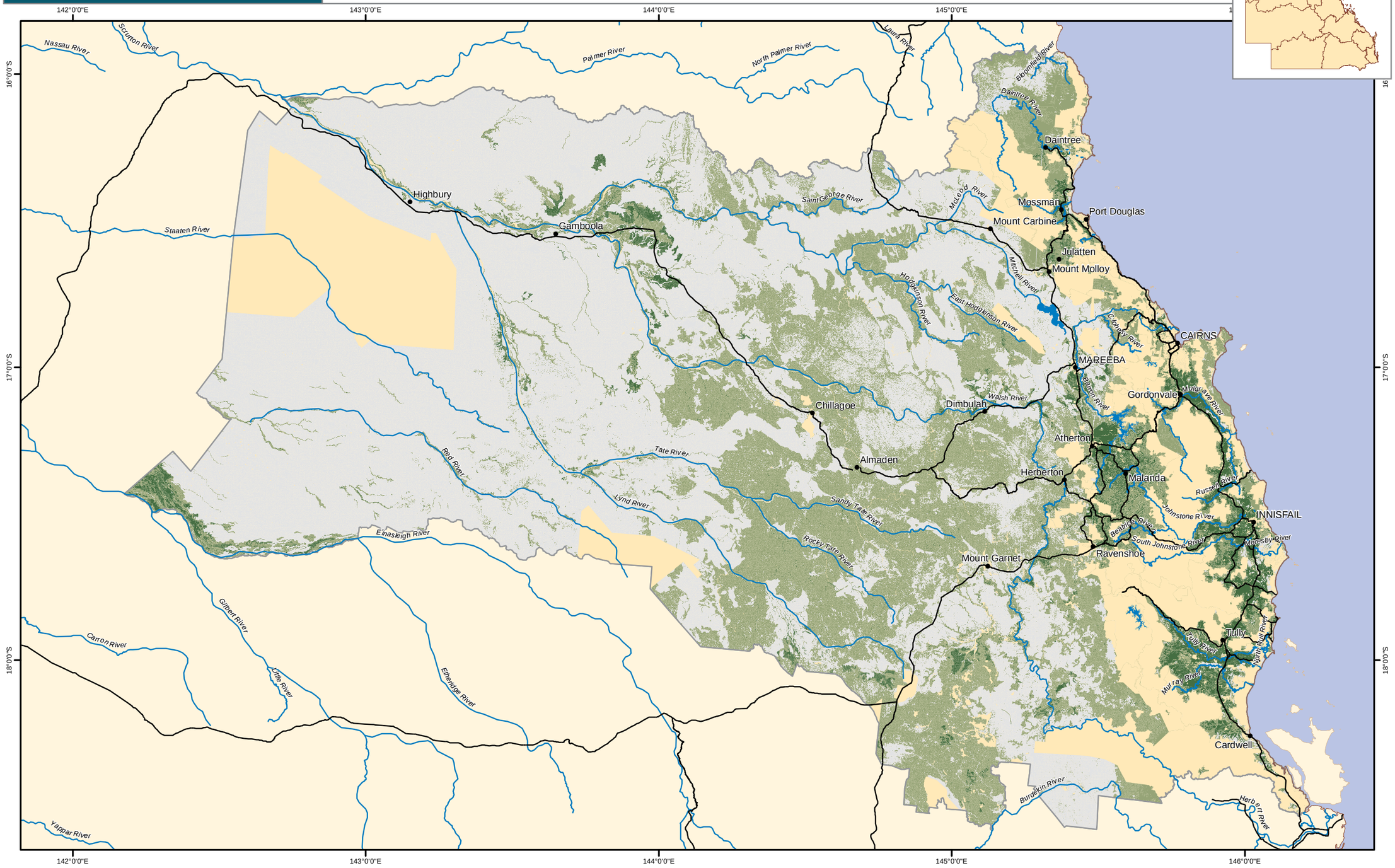
N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 6.14 Sown pastures

This map shows land identified by the audit as currently sown to pasture grasses. It also shows land identified as not currently sown to pasture grasses but having potential to be used for that purpose. For the purpose of the audit, sowing of pastures is considered to be the deliberate introduction of pasture grass varieties and species. It includes distribution of pasture grass seed preceded by cultivation or other management actions (such as fire) to create conditions conducive to successful establishment of the introduced grasses. It does not include naturalised introduction of exotic grasses without deliberate management or the supplementation of native grass pastures with introduced legumes. It is not possible with the data and tools available to the audit to map the occurrence of these supplemented pastures.

Land shown as currently sown to pasture has been identified using the approach outlined by Peck et al. (2010). This is land that currently has no (or very little) tree cover, has a mean annual rainfall greater than 500 mm and is of a GLM land type (http://futurebeef.com.au) that is considered to be suitable for pasture improvement. Land that is urban, intensive use (such as mining), national park, managed by the Department of Defence, permanently under water or currently cropped is **excluded**.

Land shown as having potential to be used for sown pastures:

a) **includes** land of a GLM land type that is considered to be suitable for establishing and maintaining sown pasture but currently has trees on it

b) **excludes** land that is urban, intensive use (such as mining), national park, managed by the Department of Defence or permanently under water.

In identifying this land, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses or competing potential land uses) that are important influences on management decisions made by producers who drive land use. These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

It should not be assumed from this study that all (or any particular portion of) land identified as having potential to support improved pastures will or should be converted to that use. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by constraints that have not been included as criteria in the mapping, for example natural resource regulations relating to vegetation management.

Far North Queensland
Areas suitable for sown grass species and areas predicted to have sown grass species established

Legend

- Sown grasses present in a significant density
- Potential for broadscale introduction of sown grass species
- Low potential for broadscale introduction of sown grass species
- Areas excluded from potential (see explanatory notes)
- Region boundary
- Roads
- Rivers
- Towns

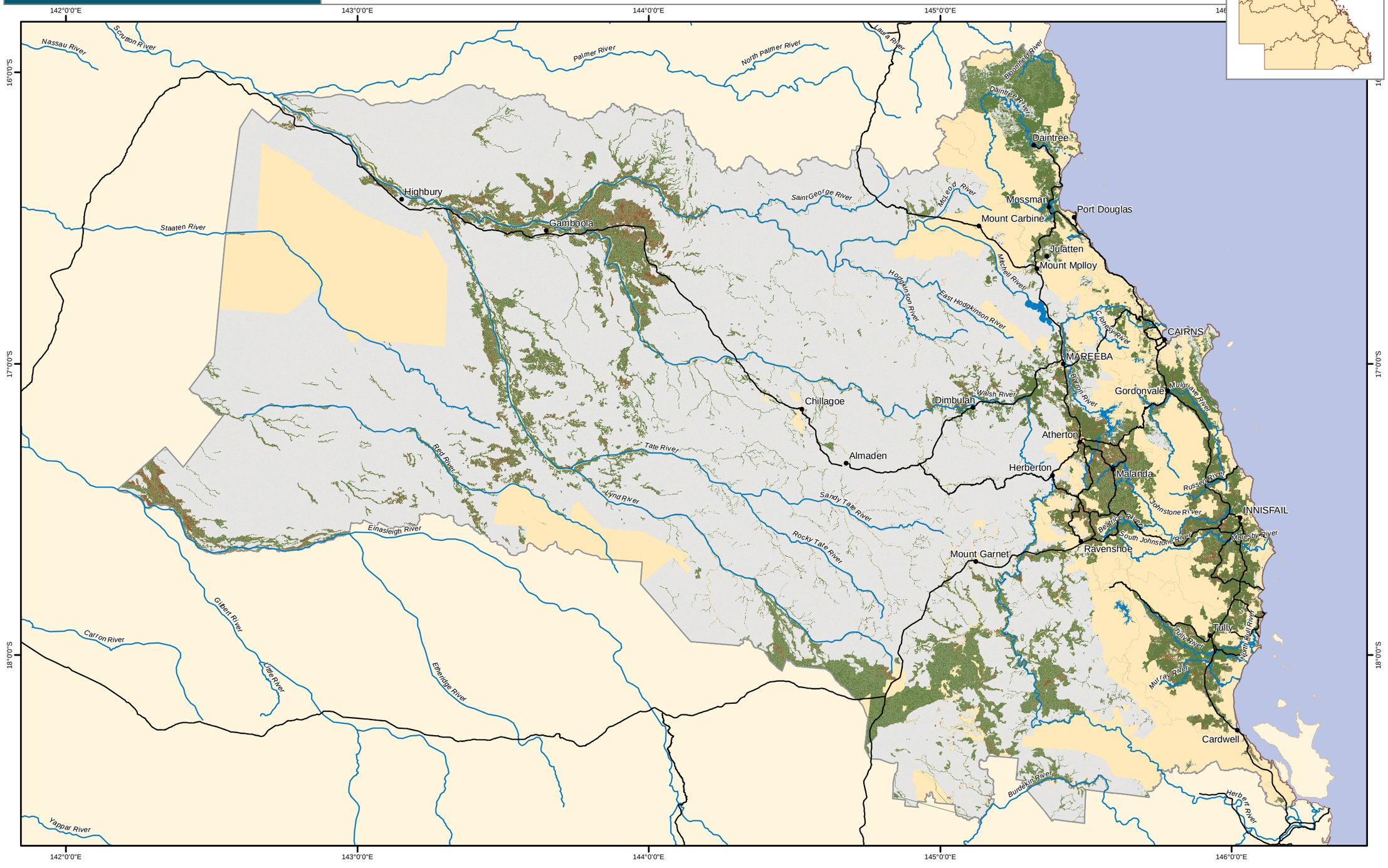
N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 6.15 Native forestry

This map shows land identified by the audit as currently being used for production of sawlogs and/or other timber products from native forestry. This land has been identified on the basis that it is either freehold land that is covered by a forest practice notification under the *Vegetation Management Act 1999* or is state-owned land over which the Queensland Government has a timber interest (as indicated by it being covered by a Department of Agriculture, Fisheries and Forestry (Queensland) Forestry Division MUID).

The map also shows land identified as not currently being used for production of sawlogs and/or other timber products from native forestry but having potential to be used for that purpose.

For land to be rated by the audit as having potential for sawlog as well as non-sawlog timber production, it must also be a regional ecosystem that contains species (as listed in the REDD description) known to produce commercial sawlogs. For land to be listed as high potential for sawlog production, the canopy top height for that regional ecosystem must also exceed the threshold determined by the audit as indicating high-productivity site conditions for production of sawlogs of that type.

Land shown as having potential for native forestry:

a) **includes** land that is mapped as currently having a woody vegetation canopy of greater than 15 per cent (SLATS foliage projective cover)
b) **excludes** land that is cleared of forest, urban, intensive use (such as mining), national park, managed by the Department of Defence or permanently under water.

In identifying this land, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses and competing potential land uses) that are important influences on management decisions made by producers who drive land use. These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

Access to processing facilities can also be a major consideration in determining the potential for land to be used for native forestry. However, it was not possible in this analysis to determine with any confidence what the critical threshold distances are. Therefore, while the locations of existing sawmills are shown on the map as a general guide to those interested in considering this factor, distance from sawmills has not been included in the analysis.

It should not be assumed from this study that all (or any particular portion of) land identified as having potential to be used for native forestry should or will be converted to that use. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by natural resource regulations such as those for vegetation management.

Far North Queensland
Potential and current native forestry

Potential based on commercial tree species, tree height, FPC>15%

Legend

- High potential for sawlog and non-sawlog products
- Potential for sawlog and non-sawlog timber products
- Potential for non-sawlog timber products only
- State owned land timber interests (Forestry Act 1959)
- Forest practice notifications on private land (Vegetation Management Act 1999)
- Region boundary
- Areas excluded from potential (see explanatory notes)
- Saw mills for native timber (within 100km of region)
- Roads
- Rivers
- Towns

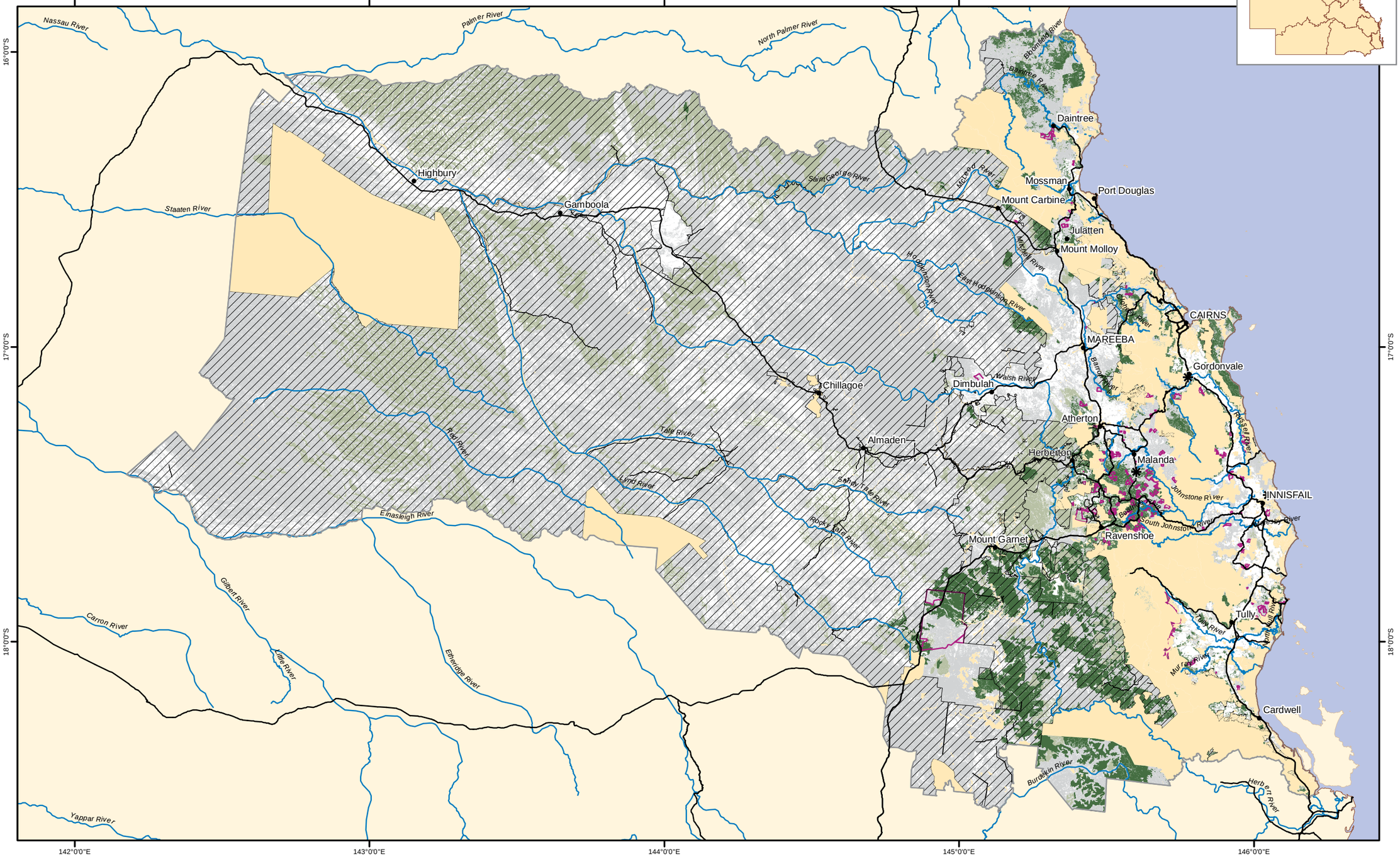
N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 6.16 Plantation forestry

This map shows the land identified by the audit as currently being used for the agricultural land-use category 'plantation forestry'. It also shows land identified as not currently used for plantation forestry but having potential to be used for this purpose. Land shown as currently being used for plantation forestry has been identified from mapping provided by HQPlantations, ABARES and FEA Holdings. Areas represented in this mapping have been classified as either hardwood or softwood by experts with local knowledge.

Land shown as having potential for plantation forestry:

a) **includes** land of agricultural land class A, class B and class C1 (as well as class C2 and class C3 for softwoods) that has slope less than 25 per cent and rainfall greater than 700 mm (or 800 mm for softwood) for 7 out of 10 years

b) **excludes** land that is urban, intensive use (such as mining), national park, managed by the Department of Defence or permanently under water as well as land that has cracking clay soils.

In identifying this land, the audit **did not consider** a range of business factors (such as markets, pre-existing land uses and competing potential land uses) that are important influences on management decisions made by producers who drive land use. These factors and how farmers respond to them are highly variable across space and through time. It was not possible to measure the effects of these factors with any confidence within the time and resources available to the audit.

Access to processing facilities can also be a major consideration in determining the potential for land to be used for plantation forestry. However, it was not possible in this analysis to determine with any confidence what the critical threshold distances are. Therefore, while the locations of existing sawmills that predominantly process plantation timber are shown on the map as a general guide to those interested in considering this factor, distance from sawmills has not been included in the analysis.

It should not be assumed from this study that all (or any particular portion of) land identified as having potential to be used for plantation forestry should or will be converted to that use. Land potential has been identified by the audit using a limited number of criteria for which mapping is readily available. Also, the extent to which the potential identified on this map is realised (or realisable) is strongly influenced by constraints that have not been included as criteria in the mapping, for example the availability of water for irrigation (see Map 6.2). See Section 6.1 for further constraints.

Far North Queensland
Biophysical potential for rainfed plantation forestry and current plantation forestry

Hardwood potential based on ALC 'A','B' and 'C1', slope 25%, rainfall >700mm 7 in 10 years, no cracking clays
Softwood potential based on ALC 'A', 'B', 'C', slope <25%, rainfall >800mm 7 in 10 years, no cracking clays

Legend

- Potential softwood plantations
- Potential hardwood plantations
- Areas excluded from potential (see explanatory notes)
- Current fallow
- Current hardwood
- Current mixed species
- Current softwood
- ALC data gaps
- Region boundary
- Sawmills for plantation timber
- Roads
- Rivers
- Towns

N

1:1,300,000

0 10 20 40 60 80
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries

142°0'0"E 143°0'0"E 144°0'0"E 145°0'0"E 146°0'0"E
16°0'0"S 17°0'0"S 18°0'0"S

Nassau River
Scrutton River
Palmer River
North Palmer River
Lynd River
Granite Normanby River
Bloomfield River
Daintree River
Daintree
Highbury
Gamboola
Staaten River
Saint George River
McLeod River
Mossman
Mount Carbine
Port Douglas
Julatten
Mount Molloy
Mitchell River
Hodgkinson River
East Hodgkinson River
Barron River
CAIRNS
MAREEBA
Gordonvale
Chillagoe
Dimbulah
Walsh River
Atherton
Almaden
Herberton
Malanda
Russell River
Johnstone River
South Johnstone River
INNISFAIL
Mount Garnet
Ravenshoe
Red River
Tate River
Sandy Tate River
Rocky Tate River
Elnasleigh River
Gilbert River
Carron River
Little River
Etheridge River
Tully
North Kuli River
Herbert River
Cardwell
Burdekin River
Yanpar River

Map 6.17 Data confidence in soil mapping

This map shows the variation in the relative confidence in the audit's mapping of land-use potential across the region. Land-use potential maps have been generated by the audit by combining a number of different datasets. The level of confidence in the final product is determined by the most limiting of the datasets used. This is generally the agricultural land class mapping, which was derived from a number of different land resource studies, each covering different parts of Queensland often at differing scales of resolution and with different standards of information reported. Confidence in land resource data ranges from high (where mapping is detailed and map units are described in terms of their suitability for a full range of relevant crop types and uses) to low (where mapping is coarse and map units are described in general terms only). For some parts of the state, the only available land resource information is from the *Atlas of Australian soils*. The quality of this information is considered inadequate for the audit; therefore, those areas are shown on this map as having no data.

Far North Queensland–Confidence in ALC data