Chapter **12**

Queensland Agricultural Land Audit

Darling Downs

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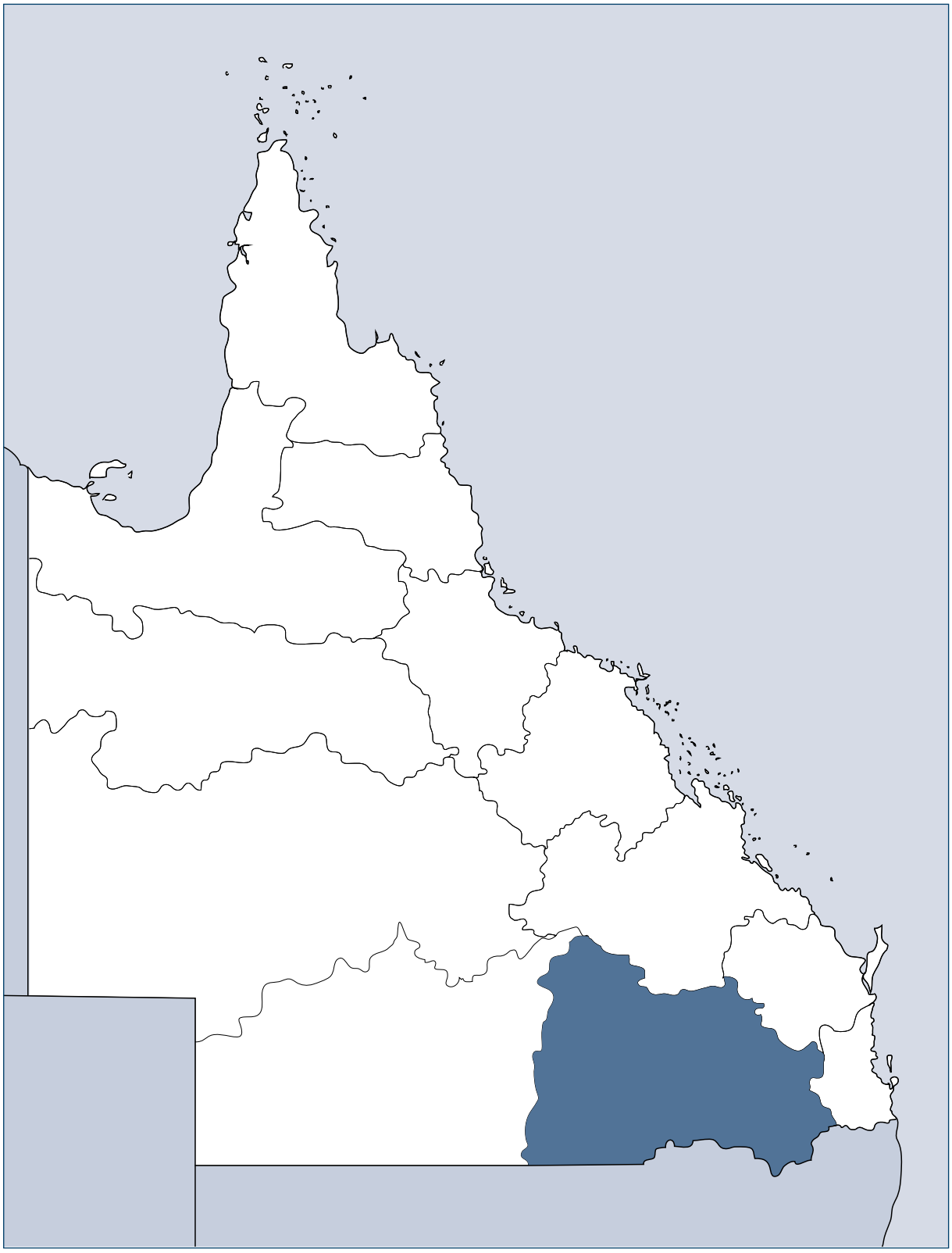
12.1 Regional agricultural profile

Map 12.1 Location of the Darling Downs Agricultural Land Audit region



12.1.1 Economic profile

The Darling Downs region is located in southern Queensland, on the border with New South Wales (Map 12.1). The region comprises the local government areas of Toowoomba Regional Council, Western Downs Regional Council, Southern Downs Regional Council, Goondiwindi Regional Council, Maranoa Regional Council and Balonne Shire Council. It has a total area of 167 357 km^2, or 9.7 per cent of the total area of the state.

As at 30 June 2011, the estimated population of the Darling Downs region was 251 104 people, or 5.6 per cent of the state's population. Growth is anticipated over the next 20 years, largely arising from developments in the energy sector. It is estimated that the region's population in 2031 will be 368 114 people, or an approximate increase of 40 per cent.[1]

The key centres for provision of agricultural and service facilities are Toowoomba, Dalby, Goondiwindi, Roma and Warwick. Toowoomba is the largest urban centre, with approximately 50 per cent of the region's population in 2011. Toowoomba provides support for agricultural industries and service-based industries such as retail, health, education and transport.

The current population represents a slightly older demographic than the state average. The median age for 4 of the 6 regional council areas was higher than the state median age of 36.2 years, with the highest median age of 41.0 years in the Southern Downs Regional Council area.

The Darling Downs represents some of the state's best agricultural land. Traditionally, the key regional primary production activities have been grazing (both sheep and cattle), dryland and irrigated cropping, and timber production. The region also supports intensive horticulture and many intensive animal production businesses.

The Southern Downs area maintains orchard, viticulture and vegetable production. Northern and western areas of the Darling Downs region carry larger areas of grazing production. The central and south-eastern areas are predominantly broadacre cropping.

The Darling Downs has been farmed for much of Queensland's history, with the area first settled in 1840. Traditionally, the country was predominantly used for grazing; however, cropping became extensive and mechanised as a result of soldier selections following World War II.[2] The region has already developed the best areas of cropping land. Past farmers have tried and tested the region and have naturally selected the best cropping land to develop. The remaining areas, while they have potential, are limited by some form of constraint.

More recently the economic structure of the region has shifted, with the expansion of mining and coal seam gas exploration and development. The Darling Downs still accounts for 20.3 per cent of the total number of businesses registered in the agriculture, forestry and fishing industries in Queensland.

In 2011, the predominant agricultural activity in the region was cropping (valued at over $1.5 billion) followed by cattle production (valued at $500 million). However, this can fluctuate year to year according to climate variability and market prices. The 2011 data indicates cropping was the predominant industry across the Balonne, Goondiwindi, Southern Downs and Western Downs local government areas. Livestock production was strongest in the Toowoomba, Western Downs and Maranoa local government areas.

1 Australian Bureau of Statistics 2012, dataset from Queensland regional profiles (generated 23 May 2012), Office of Economic and Statistical Research, Queensland Treasury and Trade.

2 More information is available at http://queenslandplaces.com.au

These figures are not indicative of specific growing areas for agricultural production—such as the orchard fruit (including nuts) and grape industries in the Granite Belt worth over $30 million in a relatively small growing region due to highly specific microclimate, rainfall and topographic conditions. The Granite Belt wine grape production represents 75 per cent of the state's grape commodity value. The Toowoomba local government area supports a strong poultry egg production sector worth over $127 million, located within the Millmerran and Pittsworth districts, and represents 85 per cent of the state's value of commodity.[3]

The unemployment rate in the Darling Downs region for the 2011 December quarter was 4.4 per cent, compared with 5.5 per cent in Queensland.[4] Of those employed, 13.1 per cent are within the Agriculture, Fisheries and Forestry industries, compared to the Queensland state average of 3.4 per cent. Agriculture, Fisheries and Forestry businesses registered in the region represent 34.7 per cent, compared to the overall Queensland state average of 11.1 per cent.[5]

Land values across the region vary significantly according to the productivity of the land (Table 2.1). In the horticulture-growing region in the Southern Downs local government area, market value of property can be as high as $32 000 per hectare for prime horticulture land—representing a 250 per cent increase in market price valuation over the past 10 years from $9000 per hectare in 2001.

This trend is also evident for less desirable land. Remnant forest areas in the Balonne and Maranoa local government areas, for example, have a current market valuation of $60 and $100 per hectare respectively, representing a 200 per cent increase over the past 10 years.

The most consistently highly valued agricultural land type across the Darling Downs region is irrigated cropping land. The market price ranges from $8000 per hectare in the Southern Downs and Toowoomba local government areas, to $10 000 per hectare in the Balonne local government area and $12 500 per hectare in the Goondiwindi local government area.

Irrigated cropping land has not increased in price as much as other land types in the region. The increase in irrigated cropping land over the past 10 years is highly variable across the local government areas. Since 2001, the increase has ranged from 25 per cent in Goondiwindi, 45 per cent in Toowoomba, 66 per cent in Balonne and 160 per cent in Southern Downs.

3 Australian Bureau of Statistics 2012, 7503.0—Value of agricultural commodities, small area data, 2010–11 (09 Nov 2012 release set).

4 Australian Bureau of Statistics 2012, dataset from Queensland regional profiles (profile generated 23 May 2012), Office of Economic and Statistical Research, Queensland Treasury and Trade.

5 Australian Bureau of Statistics 2012, dataset from Queensland regional profiles (profile generated 23 May 2012), Office of Economic and Statistical Research, Queensland Treasury and Trade.

Table 12.1 The change in land values for the Darling Downs 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		
Balonne Shire Council	Irrigated arable	6 000	12 000	10 000	+67	8 000 to 45 000
	Dryland arable	350	1 000	1 000	+186	1 000 to 17 500
	Grazing	100	400	300	+200	20 to 80 000
	Remnant forest	20	60	60	+200	35 to 8 500
Goondiwindi Regional Council	Irrigated arable	10 000	14 500	12 500	+25	8 000 to 45 000
	Dryland scrub arable	1 200	2 500	2 000	+67	1 000 to 17 500
	Scrub grazing	450	1 200	900	+100	900 to 900
	Forest grazing	250	650	550	+120	24 to 15 000
	Traprock	250	650	550	+120	550
	Remnant forest	80	190	270	+238	35 to 8 500
Maranoa Regional Council	Scrub	600	2 000	1 600	+167	400 to 1 600
	Box forest	400	1 200	1 000	+150	1 000
	Dryland arable	1 200	2 500	2 000	+67	1 000 to 17 500
	Remnant forest	30	100	100	+233	35 to 8 500
Southern Downs Regional Council	Irrigated arable	3 000	10 000	8 000	+167	8 000 to 45 000
	Horticulture	9 000	35 000	32 000	+256	32 000
	Forest grazing	1 000	3 500	2 500	+150	24 to 15 000
	Traprock	260	650	550	+112	550
	Remnant forest	80	200	300	+275	35 to 8 500
Toowoomba Regional Council	Arable treeless plain	4 000	6 000	5 500	+38	5 500 to 5 750
	Arable box forest	2 400	4 000	3 750	+56	3 750
	Forest grazing	800	1 900	1 900	+138	24 to 15 000
	Irrigated arable	5 500	8 500	8 000	+45	8 000 to 45 000
	Remnant forest	100	250	250	+150	35 to 8 500
Western Downs Regional Council	Arable treeless plain	4 000	6 250	5 750	+44	5 500 to 5 750
	Arable brigalow scrub	2 500	4 000	4 000	+60	4 000
	Brigalow scrub grazing	700	2 000	1 800	+157	1 800
	Open box forest grazing	400	1 200	1 100	+175	1 100
	Remnant forest	75	250	250	+233	35 to 8 500

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

12.1.2 Strengths, weaknesses, opportunities and threats

Key regional issues

- The region does not have the reliability and quantity of water supply to support expansion of agricultural sectors.
- The region has a well-established, significant broadacre cropping area.
- Significant economic impacts on agriculture from the mining sector include competition for land and water, and access to transport and labour. Natural resource impacts include water quality and damage to the soil resource.
- Urban and peri-urban expansion of regional centres has limited options to exclude growth into agricultural areas.

There are a range of socio-economic and environmental characteristics that make the Darling Downs region a significant agricultural area for Queensland. However, growth of agricultural industries in the region faces significant challenges. Outlined below are the strengths (existing factors that favour agricultural production), weaknesses (unfavourable conditions that hamper the success of agricultural production), opportunities (actions that could be taken to enhance future agricultural production) and threats (issues that could negatively impact on agricultural production), which provide a snapshot of some of the key issues impacting on the potential for agricultural growth in the region.

Strengths

The strengths of the region include the following:

- The region contains some of Queensland's most diverse and productive agricultural land, with a climate able to sustain a strong and diverse agricultural supply chain. Primary producers manage the highly variable climate through adaptive management systems.
- The alluvial deposits of the Condamine River form what are probably the most arable soils in Australia.
- There are significant groundwater resources in the Condamine Alluvium, Condamine Basalts and Great Artesian Basin.
- There are significant surface water resources within the Condamine–Balonne, Border Rivers and Moonie River catchments. These include the upper Condamine, Chinchilla Weir, St George, Border Rivers and Macintyre Brook water supply schemes, which are based on supplying water for major infrastructure. The vast majority of water allocations within these catchments may be traded on either a temporary or permanent basis. Refer to Section 12.1.4 for more information on water resources.
- The region is linked to South East Queensland, with access to markets and ports by major road, rail and airport infrastructure (although there are issues with the capability of such networks, particularly the descent of the Great Dividing Range to the Port of Brisbane).
- Local grain supplies are available to support feedlot production of beef cattle, poultry and pigs.
- Roma Saleyards is the largest cattle-selling centre in the southern hemisphere.
- There are strong, established centres in some areas (e.g. towns along the Warrego and Carnarvon highways).
- Queensland's traditional hardwood and cypress pine timbers are world-class, and are likely to attract increasing demand as international availability of this quality of specialty timber decreases.
- The importance of the Darling Downs cropping zones is increased because they are geographically and climatically separate from the Central Queensland region, and thus offer alternative production zones when conditions in the Central Queensland region are unfavourable (and vice versa).

Weaknesses

The weaknesses of this region include the following:

- In recent times, evidence has emerged of conflict between agriculture and other activities (such as mining and gas exploration, and urban development), and between different agricultural activities for access to and use of natural resources, labour or supporting infrastructure.
- There are issues surrounding the quality and capacity of transport networks to meet current and future requirements (e.g. load limits on bridges, competition for access to rail freight and bottlenecks in the transport network).
- There is a history of prolonged drought periods impacting on water quality, flows and quantity.
- There are potential short-term and long-term impacts of coal seam gas, mineral exploration and other mining activities on water quality, flows and quantity.
- There are difficulties attracting and retaining skilled workers, unskilled workers and residents to the region; providing affordable housing; and creating opportunities for young people who have traditionally migrated to large urban centres. Some workers have limited transportation and require work close to towns, as well as affordable housing.
- Urban encroachment on traditional farming areas and allied conflicts over odours and pesticide usage are issues close to the eastern fringe where water supplies, markets and infrastructure have previously encouraged intensive agricultural industries to locate.
- Processing industries tend to be on the eastern side of Great Dividing Range (South East Queensland), whereas production in the Darling Downs regions is on the western side.
- Key biosecurity issues for agricultural production on the Darling Downs include
  - invasive plants and animals—for example, parthenium weed (*Parthenium hysterophorus*), African boxthorn (*Lycium ferocissimum*), wild dogs and feral pigs
  - plant diseases—for example, fusarium species, rusts and stored grain insects
  - animal diseases—for example, prevention of cattle tick incursion, prevention of bovine and ovine Johne's disease, and ephemeral fever.
- Increased investment in amenity farming (hobby/lifestyle farming), especially on the eastern Darling Downs, occupies suitable land that could otherwise be available for agriculture. In some cases, there are biosecurity issues due to the lack of awareness or experience of landholders.
- For some horticultural activities, distance from, and access to, markets is a limiting factor to products sold at a viable price in domestic or export markets.
- Apart from some small volumes of unallocated water reserved by water resource plans (subordinate legislation under the *Water Act 2000*), the water resources of the region are fully allocated to existing entitlement holders.
- Cross-border issues between New South Wales and Queensland—such as different transport requirements, daylight savings time differences, state tax anomalies and legislative differences—create difficulties for agribusinesses in the southern parts of the region.

Opportunities

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

- Water produced in the coal seam gas extraction process (dependent on water quality and longevity of supply) could be used for agricultural uses, such as leucaena species, grass pasture improvements, hardwood plantation timber, other opportunity crops and plant production for biodiesel.
- Agriculture-based tourism could be expanded (especially in the specialty production system of the Granite Belt).
- There is an ability to respond to increased demand for fresh fruit and vegetables, as the population and export opportunities increase.
- The infrastructure exists for ethanol and biogas production (e.g. large bioethanol refinery is currently located in Dalby).
- Hardwood plantations could be developed for timber and/or carbon sequestration using irrigation from mining activity, such as coal seam gas extraction, if the water quality is adequate.
- Regionally based processing facilities could be constructed to develop the meat chicken and egg industries.
- There is potential for partnerships between private and public companies to enable the construction of infrastructure and delivery of services. This could include funded infrastructure projects to expand the road and rail network, or other infrastructure that can help support agriculture now and into the future (e.g. a second range crossing, using recycled water from South East Queensland for irrigation and infrastructure developments such as the Trans Regional Amalgamated Infrastructure Network (TRAIN) concept, which is a proposal by a private company to expand the network of road, rail and water infrastructure across southern Queensland and northern New South Wales).

Threats

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

- There is the threat of rising groundwater and increasing salinity in some cropping lands, particularly in some irrigated areas.
- Surface water sedimentation and increased nutrients as a result of run-off from agricultural areas is a threat to water quality.
- There is potential for reduction of both surface water and groundwater allocations for these areas, as water would be prioritised for increasing populations as opposed to agricultural usage.
- Although the Murray–Darling Basin Plan 2012 (Cwlth) has been finalised, the full details of water cutbacks are not yet known. The Commonwealth-accredited water resource plans come into effect in 2019 and the amount of water required for basin health will continue to be monitored and reviewed through to that time. A gradual adjustment process was instigated to allow communities time to adjust to a future with less water availability.
- Usage of grain for ethanol and biogas production is a threat to intensive animal industries, as it would potentially increase the cost and decrease the availability of feed grains.

12.1.3 Climate

The Darling Downs region has a variety of different climate zones supporting distinct production systems. The region has an average daily temperature range of 12.4–26.9 °C, and on average the Darling Downs region receives 581 mm of rainfall each year. Rainfall variability is high and the region has a history of prolonged drought periods and significant floods.

Rainfall varies, with the highest annual rainfall on the Southern Downs at 750–850 mm and the lowest on the Western Downs at 500–600 mm. Compared with other areas in Queensland, there is minimal rainfall variation between the dry and wet seasons in the Darling Downs, with only 100 mm total rainfall difference between the two seasons.

The Darling Downs has extensive flood plains that are subject to inundation. The most significant effects of flooding along the river systems in this region are the widespread inundation of agricultural land, the isolation of rural homes and properties, and the loss and damage suffered in these areas. Records of large floods along the Balonne River extend back as far as 1890 at St George, with extensive records at several other locations on the main stream. Major floods along the Balonne River occur regularly, on average every 2 years.

Projections for the eastern Darling Downs area include a decline in rainfall, with increasing temperature and evaporation in conjunction with more extreme climate events. Climate on the Darling Downs is projected to become warmer with longer dry periods interrupted by more intense rainfall events. Average annual temperatures are projected to be around 1 °C warmer by 2030, with little variation in projections across the seasons. By 2030, the average number of days per year over 35 °C, is expected to increase from 31 to 46 in Miles, and up to 50 by 2050.[6]

More intense and long-lived cyclones have a greater chance of impacting on inland regions such as the Darling Downs region—through the decay of cyclones into rain-bearing depressions or the cyclones themselves tracking further inland. Agriculture is a significant industry for the Darling Downs and such industries will likely be exposed under future changes to the climate.

The impacts of climate variability and change could affect production and land suitability, and require adaptation to maintain production and take advantage of emerging opportunities. Higher temperatures can affect land suitability for particular horticulture crops, affect the timing of crops and increase the need for shade for feedlots. Increased evaporation and variability in rainfall can affect crop production and pasture quality. The increased risk of intense rainfall events may exacerbate current flooding issues—including loss and damage to farming and transport infrastructure—affecting access to markets.

12.1.4 Water resources

Surface water resources

The water resources in the Darling Downs audit region are regulated by water resource plans and resource operations plans. Refer to Map 12.1 for the water resource planning areas relevant to the Darling Downs region. These plans apply to water in a watercourse and/or lake, and to overland flow water. The vast majority of entitlements to take water are tradable water allocations—tradable to the extent that a water allocation is separate to land and is authorised by a separate title that can be mortgaged and encumbered. Water allocations are categorised as either supplemented (i.e. based on conserving water in major infrastructure like Beardmore Dam for later delivery and use) or unsupplemented (i.e. taking water from flows as the opportunity presents, previously known as water harvesting).

6 For more information, refer to *Climate change in the eastern downs region* at ‹http://www.ehp.qld.gov.au/climatechange/pdf/regionsummary-easterndowns.pdf›.

Water sourced from supplemented schemes is generally associated with a greater reliability of supply and access than unsupplemented water. Unsupplemented water (which is accessed directly from stream flow) is not as reliable, as most of the streams in the audit area are short-lived with highly intermittent flows relating to rainfall. Unsupplemented water is either taken on an opportunistic basis and applied directly to crops or is stored in off-stream storages.

The Condamine–Balonne catchment is approximately 124 500 km^2 and extends from Killarney in the upper reaches to the border with New South Wales (125 km south of St George). The key regional and urban centres are Toowoomba, Warwick, Dalby, Chinchilla, Roma and St George. The major rivers are the Condamine, Balonne and Maranoa rivers, and the streams of the lower Balonne distributary system, which includes the Culgoa, Ballandool, Bokhara and Narran rivers.

The water taken under water entitlement is generally used for the purposes of irrigated agriculture, urban water supply, mining and industry. There are three major water supply schemes within the catchment based on Leslie Dam, Chinchilla Weir and Beardmore Dam, which supply 96 000 ML of nominal volume under supplemented water allocations. The long-term average annual take from unsupplemented sources is estimated to be approximately 620 000 ML. Approximately 60 per cent of the allocated water (i.e. both supplemented and unsupplemented) is located within the lower Balonne. In addition to sourcing water from traditional supplemented and unsupplemented water allocations, SunWater have recently been issued a beneficial-use approval to use Chinchilla Weir to store and distribute treated coal seam gas water for irrigation and other purposes within the water supply scheme area.

The Border Rivers catchment is approximately 26 000 km^2 and extends from Stanthorpe in the upper reaches downstream to the border with New South Wales near Mungindi. The key regional and urban centres are Stanthorpe, Goondiwindi, Texas and Inglewood. The major rivers within the catchment are the Severn, Dumaresq, Macintyre, Barwon and Weir rivers, and the Macintyre Brook.

The water taken under water entitlement is generally used for the purposes of irrigated agriculture, urban water supply, mining and industry. There are two major water supply schemes within the catchment based on Glenlyon Dam and Coolmunda Dam, which supply 109 000 ML of nominal volume under supplemented water allocations. The long-term average annual take from unsupplemented sources is estimated to be approximately 200 000 ML. The Water Resource (Border Rivers) Plan 2003 includes a reserve of 4500 ML of unallocated water for irrigation and town water supply.

While there has been some continuing interest in activating this potential, no water has been released at this point in time. The above description relates to the Queensland section of the Border Rivers catchment only. The Dumaresq, Macintyre and Barwon rivers form the state border between Queensland and New South Wales. Sharing of the water resources of the border stream is in accordance with the New South Wales – Queensland Intergovernmental Agreement 2008. This agreement also provides for interstate trading of supplemented and unsupplemented water allocation on both a temporary and permanent basis.

The Moonie River catchment is approximately 14 860 km^2 and extends from south of Dalby in the upper reaches downstream to the border with New South Wales south of Thallon. The key regional centres are Moonie, Westmar, Nindigully and Thallon. The major watercourse within the catchment is the Moonie River. The water taken under water entitlement is generally used for the purposes of irrigated agriculture and urban water supply. There are no water supply schemes within the catchment and hence no supplemented water allocations. The long-term average annual take from unsupplemented sources is estimated to be approximately 30 000 ML.

Case study 12.1 Coal seam gas water on the Darling Downs

The coal seam gas (CSG) industry is currently expanding rapidly in Queensland. CSG production has doubled within the last decade and, with the number of wells quadrupling in the last 5 years[7], this expansion is expected to continue for some time.

'Associated water' is a by-product of producing CSG. Associated water is extracted from deep underground as part of the process of depressurising the gas so that it can be extracted. Very large quantities of water can be yielded through this process, especially during the early stages of well development. Forecasting how much associated water will be produced as a result of CSG development is challenging, due to uncertainties about the physical properties of coal seams and how the industry will develop. Various estimates have been made, both by CSG companies and by other parties. Recently, the Department of Natural Resources and Mines has developed a software tool capable of forecasting where, when and how much CSG water will be produced over the lifetime of the CSG industry.[8] This tool can provide estimates for specific areas such as the Darling Downs region.

The software's estimates of CSG water production in the Darling Downs region are shown in Figure 12.1. This graph summarises the results from 99 separate simulations, which allow for variations in inputs such as the operational life of gas wells and the rate and intensity of industry expansion. The middle line represents the average of all 99 simulations, while the two dotted lines show the 25th and 75th highest estimates at each point in time. These provide a realistic range of probable outcomes given the current state of knowledge. The estimates in Figure 12.1 are based on an industry development scenario that considers the location of favourable coal seams, regional infrastructure such as towns and roads, and the present state of gas production.

Figure 12.1 Estimated associated water production in the Darling Downs region—the middle line is the average estimate based on 99 simulations, while the dotted lines represent the 25th and 75th highest estimates

7 Department of Employment, Economic Development and Innovation 2011, *Queensland's petroleum exploration and development potential*, State of Queensland.

8 Klohn Crippen Berger 2012, *Forecasting coal seam gas water production in Queensland's Surat and southern Bowen basins*, Department of Natural Resources and Mines, Queensland.

These estimates suggest that production in the region will peak at a rate of between 160 and 240 gigalitres per year in around 2023, and then begin to decline until it is nearly exhausted by 2060. However, it is important to note that the availability of CSG water in any given area within the Darling Downs region will not necessarily follow the same profile.

Another issue with potential agricultural use of associated water is the variability and uncertainty of supply. This uncertainty is exacerbated by the geographic spread—wells are distributed across more than 40 000 km^2. Infrastructure to capture, store and distribute water for irrigation is expensive. Investors need to be confident about security of supply to commit such large sums up-front.

Shortage of water is a constraint to agriculture throughout much of Queensland. It is not surprising, therefore, that there is much speculation about the potential for CSG water to help fuel agricultural productivity increases and expansion. Based on a conservatively estimated application rate, associated water has the potential to irrigate in excess of 30 000 hectares of agricultural crop for each of the next 20 years.

The CSG industry is concentrated in central Darling Downs between Dalby, Roma and Injune. This area is among some of Queensland's most important agricultural land, which is prized for the production of grain crops and cotton. There is already extensive irrigation in this region, with almost 400 000 hectares of crops grown through the addition of supplementary water. However, with almost 2 million hectares of land under dryland broadacre cropping in the region, there is also considerable potential to expand irrigation if more water were available.

Water produced by the CSG industry is generally unsuitable for direct agricultural use and therefore needs disposal via treatment that requires investment of additional effort and technology. Options for treated water being trialled include tree crops for timber and biofuels, as well as grains (such as sorghum, maize and wheat) and fodder (such as leucaena and lucerne).[9]

Associated water could be made available to agriculture and other uses, but not without significant costs. In 2008–09, Queensland farmers estimated that the full cost of using irrigation water from conventional sources was, on average, $134 per ML.[10] Using CSG water for agriculture presents significant challenges, the most significant of which relates to salinity and sodicity interactions between the CSG water and soils. Raw associated water typically contains salts (notably sodium, bicarbonate and chloride) at concentrations well in excess of fresh water. It can also contain other toxic and potentially environmentally damaging pollutants (such as fluoride, boron and some heavy metals). Past studies[11] have shown that undiluted, untreated CSG water is not suitable for prolonged agricultural use without risking reduced productivity and environmental damage. To make it acceptable for beneficial re-use options requires treatment, such as reverse osmosis.

9 Australia Pacific LNG 2010, *Australian Pacific NLG project environmental impact statement*, March 2010, Volume 5: Attachments, Attachment 24: Adaptive associated water management plan—gas fields, Australia Pacific LNG.

10 Australian Bureau of Statistics, 46180DO001_200809—Water use on Australian farms, 2008–09.

11 Raine SR & Ezlit YD 2007, *Evaluation of the soil physical impacts associated with applying coal seam gas water amended with sulphuric acid for irrigation purposes,* National Centre for Engineering in Agriculture Publication 1002524/2, University of Southern Queensland, Toowoomba.

12.1.5 Infrastructure

Toowoomba offers a large regional business and industrial centre that provides extensive goods and services to the surrounding region. The Dalby, Roma and St George townships are located within close proximity of the Balonne and Condamine river systems. These towns face widespread infrastructure and supply-chain interruptions during periods of heavy inundation of water.

Access to population and labour sources in the western areas of the Darling Downs limits the expansion of horticulture. Texas, for example, is starting to develop horticultural enterprises; however, availability of labour is the key constraint. Maize and other crops with lower labour needs are being more closely examined.

The region has good access to schooling and regional population centres to support labour needs. However, west of Dalby the level of social infrastructure is reduced, until Roma. These larger communities support hospitals, public and private schooling, and tertiary study institutions to support families and employees in the industry.

Increasing demands on hard (roads, rail) and soft (health, education facilities) infrastructure as a result of mining growth throughout the region is impacting on agricultural development and regional communities. For example, housing affordability and availability, education facilities and social support services are all under significant pressure. This impacts on the long-term liveability of the region and, in turn, affects the region's ability to attract a suitable workforce.

Meat abattoirs, egg processing, cotton gins and bulk grain storage and handling support the key agricultural industries throughout the region. Extensive industrial developments are established in Toowoomba, Chinchilla, Goondiwindi, Dalby and Roma to support agricultural industrial needs. This includes necessary inputs such as fertiliser, stockfeed and mechanical services. However, while the Darling Downs is serviced by processing and value-adding facilities, the majority of agricultural production is transported to South East Queensland for processing.

The Darling Downs is located within a short transportation distance on good highways to Brisbane. This opens up the region to a lot of commodities that are sensitive to travel distances such as poultry, dairy and some horticultural crops. Road transportation, however, does face difficulties and limitations crossing the Great Dividing Range in Toowoomba, with only one main road crossing for freight. During times of heavy rain, accidents and other range blockages, the additional costs of transportation of stock and freight are significant.

The agriculture sector has historically relied on rail as a key mode of transport across a range of commodities. Rail transportation faces competition from other industries to access rail freight facilities—access to rail freight opportunities has been greatly reduced in recent years due to increased demand from the mining industry.

There is a major domestic airport located at Roma. Local airports facilitating regional air travel, crop spraying and related industry needs are located in Toowoomba, Dalby, St George, Stanthorpe and Warwick.

The region is well supplied with power stations, with coal, gas or combined gas/solar power stations located in Dalby, Roma, Kogan, Condamine and Oakey.

Map 12.3 illustrates the key infrastructure within the region.

12.1.6 Vegetation

There is an extensive variety of soil and vegetation bioregions on the Darling Downs. These include alluvial plains, poplar box solodic plains, cypress pine sand plains, brigalow plains, brigalow rises, rolling downs/Walloons, ironbark solodics, poplar box solodics, Marburg sandstone hills, mulga/gidgee lands, Yelarbon Desert, basaltic uplands, granite hills and traprock hills.

The vegetation communities were generally seen as an impediment to development of productive agricultural lands by early settlers and governments. Successive generations improved their capability to transform forested landscapes into farming and grazing land. The most clearing, on advice from government policy in this area, was the Brigalow Development Scheme of the 1960s and 1970s, which resulted in extensive clearance of the brigalow lands over approximately 30 years.[12]

There are areas of land that are restricted from clearing under the *Vegetation Management Act 1999* within the Darling Downs region; however, the region is predominantly already cleared. Of the region, over 11.165 million hectares (67 per cent) is already cleared, can be cleared or is naturally open, and 534 523 hectares (3.2 per cent) requires verification before clearance. There are over 5.004 million hectares (30 per cent) that cannot be cleared (refer to Map 2.4).

A study in 2002[13] identified changes in land use and levels of clearing from 1975 to 2001 within a 1000 km^2 area, centred around the town of Pittsworth and including upland country to the east and flood plains bordering the Condamine River to the west. Analysis of 1975 and 2001 satellite imagery showed that over 53 000 hectares of vegetation on the eastern Darling Downs study area changed from one land-use class to another during the 26-year period. Of the 25 791 hectares of native vegetation cleared over that period, some 15 667 hectares were cleared for pasture while 9673 hectares were cleared for cropping.

Cropping areas increased from 86 565 hectares in 1975 to 94 419 hectares in 2001, while pasture areas increased from 24 582 hectares to 37 959 hectares for the same period.[13] The study highlighted that, from 1975 to 2001, the most significant changes in vegetation clearance and land use occurred between 1985 and 1991. Historically, the most significant clearing in the region occurred between 1850 and 1950.

The areas north of Miles and Chinchilla and west of Goondiwindi and Moonie are all predominantly state forest, national parks or conservation areas. There is an area of protected vegetation north-west of Roma that is primarily made up of state-owned leasehold land, state forests and national parks. State forests, national parks and conservation areas represent 8 per cent of the region.

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.

12 Refer to the Queensland Murray–Darling Committee *Regional NRM plan* (2004) at ‹www.qmdc.org.au/publications/download/272/plans/regional-nrm-plan/regional-nrm-plan.pdf›, accessed 24 October 2012.

13 Zammit C, Apan A, Cockfield G, LeBrocque A & Bouldin M 2002, ‘Prospects for regional sustainability: land use change in the eastern Darling Downs, 1975–2001’, *Proceedings of the 11th Australasian Remote Sensing and Photogrammetry Conference*, Brisbane, 2–6 September 2002, pp. 84–97, accessed 4 October 2012, ‹www.usq.edu.au/users/apana/landuse.pdf›.

12.2 Current and potential agricultural land use

Agricultural land use across the Darling Downs is diverse. The majority of the region (97 per cent of land use) is under agricultural production, with more intensive agricultural activities in the eastern and southern areas. Grazing and broadacre cropping are the predominant industries, occurring primarily in the central and western areas.

Grazing is the dominant land use across the region (75 per cent of agricultural land). Potential grazing land covers all agricultural land in the region (89.83 per cent). The only areas that would be unsuited to grazing are those already identified as having non-agricultural land uses.

Table 12.2 illustrates the proportions for agricultural land-use categories across the region, both current and potential. Map 12.5 illustrates current land use on the Darling Downs.

While the potential land use identifies areas ideal for particular land uses, it is common to see a variety of land uses occurring on land of different quality. This acknowledges opportunities or grower preferences to use the land for other practices.

A significant proportion of potential cropping land is used for grazing. Similarly, the horticulture industries occupy a very small footprint in the region, but have a significant area of potential land.

A number of factors influence land-use patterns, including climate, availability of water, distance to markets and access to labour. As data is at a coarse scale, it is also likely that some inaccuracy in mapping potential land has occurred.

Most soils throughout the region exhibit characteristics that constrain or preclude (if sufficiently severe) their use for one or more agricultural land uses or crop types. Almost all of the more than 4.5 million hectares of potential cropping land across the region exhibits at least one such characteristic—known as a 'limitation'—and more than half the potential cropping land exhibits four or more characteristics. The most widespread limitations of cropping land are soil salinity and erosion (wind and/or water), which affect more than half of the soils.

The soils on the Darling Downs and in surrounding areas are quite variable and include rock, sands, sandy clays, cracking clays and non-cracking clays. Around half the cropping soils in the region are also affected by a range of surface soil–related limitations including rockiness, topsoil workability and soil compaction, and microrelief affecting cultivation and tillage. Many areas, mainly in the south and east, are also affected by subsoil-related limitations such as soil water-holding capacity and soil wetness. Both soil water-holding capacity and soil wetness are strongly influenced by soil depth and subsoil properties that impede root growth and/or water movement.

Vertosols (cracking clays) are the dominant soil types used for cropping on the Darling Downs. They occur throughout the Darling Downs, but the best are in the Condamine catchment and are among the most productive in Australia in terms of crop production. The reasons for the outstanding productivity of the cracking clay soils is their inherent chemical fertility, high capacity to hold water after rain or irrigation (high plant available water capacity), location in a zone providing good natural rainfall and access to good quality groundwater for irrigation.[14]

Ferrosols (red, non-cracking clays) on the eastern Darling Downs were historically valuable soils for horticulture around Toowoomba and peanuts around Clifton. These soils are not as resilient as the cracking clays and suffer from acidification and fertility decline. Much of the area of non-cracking clays used for horticulture has been lost to urban development around Toowoomba, while to the north they are used for forest plantations.

14 Submission No. 24 to the Senate Committee Inquiry into the Impacts of Mining in the Murray Darling Basin, submitted by the Australian Society of Soil Science Inc. (ASSSI), September 2009, ‹https://senate.aph.gov.au/submissions/comittees/viewdocument.aspx?id=3391763a-7d79-4819-9582-75fc444dc565›, accessed 4 October 2012.

The Darling Downs has large areas of fertile cracking clay soils, but the most intensive agricultural development has been in areas where water supplies allow irrigation. Horticultural production in the Granite Belt is a clear exception with respect to soils—the area is dominated by sandy soils, but these are well suited to intensive horticulture where additional soil management techniques can be used. Similar soils occur elsewhere on the Darling Downs, and these may be suited to future horticultural production if water and microclimate factors are appropriate.

Table 12.2 Current and potential land area (hectares)

Queensland Land Use Mapping Program (2006)	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	2 364 119	14.15	66.64	4 208 618	25.12
Perennial horticulture	8 280	0.05	9.43	4 113 842	24.55
Annual horticulture	6 480	0.04	13.74	7 216 276	43.07
Grazing	12 591 691	75.38	8.51	16 201 568	96.70
Sown pastures	5 993 480	35.77	37.36	3 258 694	19.45
Intensive livestock	22 554	0.13	59.20	9 469 936	56.52
Other land use (non-agricultural land uses and also may include some forestry)	1 712 139	10.25	8.53		
Total	**16 705 262**	**100**			
Forestry‡ (see Section 12.2.2)					
Managed in silvopastoral systems (mixed native or plantation forestry and grazing)	3 535 924	21.10	1.84		

Note: Refer to Sections 12.2.2 (under 'Forestry') and 12.3 ('Data confidence') for a further explanation regarding the forestry datasets and methodology used.

* Potential areas includes where the majority of current production occurs as well as where production could potentially occur. Refer to Section 12.3 ('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 12.2.2 (under 'Forestry') for further information about forestry data.

12.2.1 Important agricultural areas

In the Darling Downs region, four areas have been identified as important agricultural areas.

An important agricultural area is an area that 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. Map 12.6 shows the general location of the important agricultural areas for the Darling Downs region.

Northern Darling Downs/Injune

An area of interest is the northern part of the Darling Downs between Injune and Roma. This area has been identified as an area with potential access to coal seam gas water in the future. The area supports extensive native cypress pine and hardwood forest estates. Cropping potential is also evident, although soil conformity and parthenium weed may be issues. With access to additional irrigation water and related infrastructure investment there is great potential to expand activities in the area, contributing to localised employment, private investment and industry development.

Eastern Darling Downs

The eastern Darling Downs area through to Chinchilla supports some of Queensland's best cropping lands. This area is one of Queensland's oldest, most productive and intensive broadacre cropping regions, producing over 30 per cent of the state's cropping commodity value. The area supports extensive broadacre cropping, horticulture and significant intensive livestock businesses.

The Darling Downs region supports 65 per cent of the state's pig production commodity value. Cropping and intensive livestock industries are complementary, due to the need for intensive livestock to source quality feed grain with minimal additional costs for transportation and to routinely dispose of liquid and solid waste in the local area.

Cropping in the eastern Darling Downs area is dependant on the high-quality vertosol soils that are unique to this area. There are few areas within Queensland that support such extensive soil profiles (in combination with other biophysical characteristics) better suited to broadacre cropping. Infrastructure, including water and further processing facilities, have been established (using both private and public funding) throughout the area to support irrigation and industry needs.

Granite Belt

The Granite Belt in the Southern Downs local government area is an important agricultural area. If the biophysical potential is considered alone, the area would be considered marginal cropping and grazing lands (due to specific soil characteristics). However, when combined with a unique set of climate conditions and proximity to markets, the area is ideal for many specific horticultural activities. This unique combination of climate and growing conditions also supports a strong fine-wool production industry in the area.

The Granite Belt region has been developed to support extensive pome fruit (apples and pears), stonefruit, summer vegetables, wine and grape industry development in this area. While there are small areas of production outside the Granite Belt, pome and stonefruit are not grown to the same extent anywhere else in the state. The Granite Belt produces 96 per cent of the state's pome fruit commodity value and 74 per cent of the stonefruit commodity value. The local industry supports large numbers of unskilled and semi-skilled workers from the local community.

Education and training facilities to support local viticulture and grape industry employment and skilling has been established in Stanthorpe to further assist and expand these industries in the region. The wine industry in the Southern Downs area is the strongest in the state, with over 75 per cent of the commodity value coming from this area.

Border region

The southern area of the Darling Downs (following the New South Wales border) supports a variety of broadacre cropping (both irrigated and dryland) and grazing. As with the eastern Darling Downs, the combination of biophysical attributes exhibited in this area (including slope and soil water-holding capacity) enable this region to support large areas of broadacre cropping. Near St George, the annual average rainfall is insufficient to support dryland cropping under normal growing conditions. However, the soil in this area has high water-holding capacity, which makes dryland cropping viable most years. The area also has access a substantial water supply scheme for irrigation, established using public funds. The Balonne and Goondiwindi local government areas produce 14 per cent of state's cropping commodity value. This is comprised mainly of cotton, with the Goondiwindi and Balonne local government areas producing 56 per cent of the state's cotton commodity value.

12.2.2 Industry profiles

Broadacre cropping

Current

Broadacre cropping, both dryland and irrigated, is a significant agricultural land use on the Darling Downs, using a total of 14 per cent of land. The eastern Darling Downs area has a concentration of broadacre cropping (both irrigated and dryland). A broad band in the central longitudinal area of the region is extensively cropped, but is also interspersed with grazing and other uses. Cropping diminishes to the west of Roma and St George due to the influence of lower median rainfall.

There are parts of the landscape where broadacre cropping could occur, but currently does not. The current land uses on land that would be considered potential cropping land are grazing (61 per cent), forestry (0.2 per cent) and other land uses (1.9 per cent). Cropping currently occupies 37 per cent of potential cropping land (Map 12.7).

Cropping predominantly occurs in the eastern Darling Downs area, in a band of land south of Chinchilla through to Warwick. The eastern Darling Downs area appears to have exhausted its potential, with the area being highly used for cropping. Cropping is also dominant south of St George to Moonie, but smaller opportunities may be interspersed within the area.

These cropping areas south of St George are mainly rain-fed cropping areas, with the opportunity to irrigate where water is available. While irrigation is well developed within the existing water supply schemes of the upper Condamine, Chinchilla Weir, St George, Macintyre Brook and Border Rivers, there is also extensive use of unsupplemented water in the Granite Belt, Weir River, mid Condamine and lower Balonne distributary system (i.e. south of St George adjacent to the Culgoa, Ballandool, Bokhara and Narran rivers). There is also significant use of groundwater to support irrigation from the Central Condamine Alluvium and Border Rivers Alluvium.

Potential

The lower Balonne distributary system is not considered to meet the potential broadacre cropping criteria, as it falls under the 450 mm mean annual rainfall criteria (in 7 out of 10 years). However, in the area that is irrigated, water is sourced from significant unsupplemented flow events and stored in large on-farm infrastructure for later use. Therefore, the rainfall criteria is not a limiting factor for those with access to the irrigation scheme. The dryland cropping in this area is opportunistic, as the soil has extremely high water-holding capacity and can successfully sustain crops when rainfall occurs.

Agricultural development in the western part of the Darling Downs is fundamentally limited by rainfall, with secondary soil limitations on the range of crops that could be grown (based on soil quality and type as well as rainfall).

West of Injune there is an area of potential cropping land that has the capacity for rain-fed cropping, but it's currently grazed. There are a number of potential explanations for this. One is that map units in this area are heterogeneous, so a classification of the land as potentially suitable is overly generous. Also, widespread parthenium weed incursions in this area would make cropping difficult.

Water availability is also a key determinant of irrigation potential. Until the Murray–Darling Basin Plan 2012 is implemented, there are uncertainties regarding the availability of new water resources for agricultural use on the Darling Downs. Section 12.1.4 outlines existing water resources in the region.

Horticulture

Current

Horticulture is a significant agricultural activity in the Granite Belt and the eastern Darling Downs. Pockets of horticulture also occur around Chinchilla and St George. Horticulture has a relatively small footprint on the Darling Downs, comprising a total of 0.09 per cent of land use.

For example:

- avocados are only grown in the Hampton/Ravensbourne area where deep, well-drained soils are available and very few frosts occur
- apples are grown only in the Granite Belt where winter temperatures are sufficiently low to provide the specific chilling requirements of this crop
- vegetables, such as lettuce and broccoli, are grown in the Granite Belt and eastern Darling Downs where summer temperatures do not exceed the thresholds for these crops.

Intensive annual irrigated horticulture (such as vegetables) can potentially be produced in 43 per cent of the region, of which only 0.04 per cent is currently being used for horticulture. From a soil-suitability perspective, significant areas of the Darling Downs have horticultural potential.

Currently, only 8280 hectares (0.05 per cent) is used for perennial horticultural production. Annual horticulture is similar, with only 6480 hectares (0.04 per cent) of land currently being used.

Horticulture is currently occupying areas of the Darling Downs that offer specific advantages, such as availability of water for irrigation, labour (particularly during harvesting) and soils suited to specific horticultural crops. Perennial horticulture crops have the same current constraints, together with more severe constraints on soil depth, frost occurrence, flood risk and summer rainfall.

Potential

There are large parts of the landscape where horticulture could occur, but currently does not. Across the region there are 6.2 million hectares identified as potential land for perennial crops and over 7.4 million hectares for annual horticultural crops (Maps 12.8 and 12.9).

The current land uses on land identified as having potential for annual horticulture are grazing (71 per cent), cropping (28 per cent) and other land uses (1.2 per cent).

The current land uses on land identified as having potential for perennial horticulture are grazing (82 per cent), cropping (17 per cent) and other land uses (0.97 per cent).

Not all land identified as potential horticulture areas are viable for development. Water access, market saturation and access to resources limit the entry of new horticulture developments in the region. The current constraints to realising this potential are availability of water for irrigation, specific crop-related climatic issues (such as summer and/or winter temperatures) and the availability of labour and profitable markets. Each constraint needs to be overcome for this potential to be realised.

Labour is a significant limitation to the development of horticulture in new regions. Maps 12.8 and 12.9 indicate an optimal area for labour and social catchments. This is a 50 km radius from the nearest population centre of greater than 2000 people. This boundary does not preclude development outside of these catchments; however, labour needs and sourcing of labour need to be considered in any future developments. Areas such as St George and Stanthorpe have successfully developed horticulture industries outside of the population zones by providing onsite accommodation, transportation for workers and other incentives.

Those areas in the Granite Belt region that are currently being grazed as opposed to cropped would be unsuited to horticulture due to natural resource limitations that are not mapped in the audit, such as water and rockiness. It is unlikely that land in the area not currently cropped would be used for horticulture in the future.

The area of horticulture production in the Granite Belt has not changed significantly over the past 30 years. The major limitation to expansion of horticultural cropping in this region is access to suitable land and water for irrigation. The paddocks have changed but the overall area under production has remained relatively static throughout the past 30 years. The choice of crop (apples, stone fruit or vegetables) is primarily due to producer preference and not a natural resource limitation.

Areas of potential are to the west and south of Roma. There are large areas of heavy red kandosols, which are great vegetable production soils. The soil structure is too light for broadacre crops; however, they are perfectly arable soils that haven't been developed as they have low water-holding capacity. With access to irrigation, the region could be developed for annual horticulture production.

There are areas of the region that are flood plains. For annual horticultural production this primarily affects summer crops. The risk of flooding is one factor that farmers assess each season and manage accordingly. Crop losses due to flooding in these areas are not uncommon.

Case study 12.2 Lettuce production on the Darling Downs

Horticulture in Australia comprises a large number of commodities that are grown in a wide range of production regions due to the diversity of microclimates.

Horticultural crops are particularly sensitive to temperature—most having specific temperature requirements for the development of optimum yield and quality—and it is temperature that determines to a great extent the production season and location, yield and quality performance of the majority of horticultural commodities in Australia, including lettuce.

Lettuce production in South East Queensland is an interesting example that demonstrates the influence of temperature on the production season and location, yield and quality performance of horticultural crops.

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

The main lettuce production regions in Queensland are the Lockyer Valley, Granite Belt and eastern Darling Downs (South East Queensland). Each of these production locations has a distinct lettuce production season, almost exclusively as a result of the climate.

In the Granite Belt (southern Darling Downs), lettuce production occurs only in the summer. Cold and frosty winters prevent year-round production. The first crops are transplanted in August, with harvests commencing in November. Consecutive weekly transplanting occurs until March, with harvesting completed by May, after which frosts will affect head quality.

This is in contrast to the Lockyer Valley where lettuce is a winter crop. Transplanting commences in midsummer, followed by consecutive weekly plantings until midwinter. First harvest occurs in late April/early May, with final harvest in October and harvest peaking from June to August. Lower yields and quality are often produced in October, especially in warmer years. Production over the summer does not occur because of the effects of high temperatures on head quality.

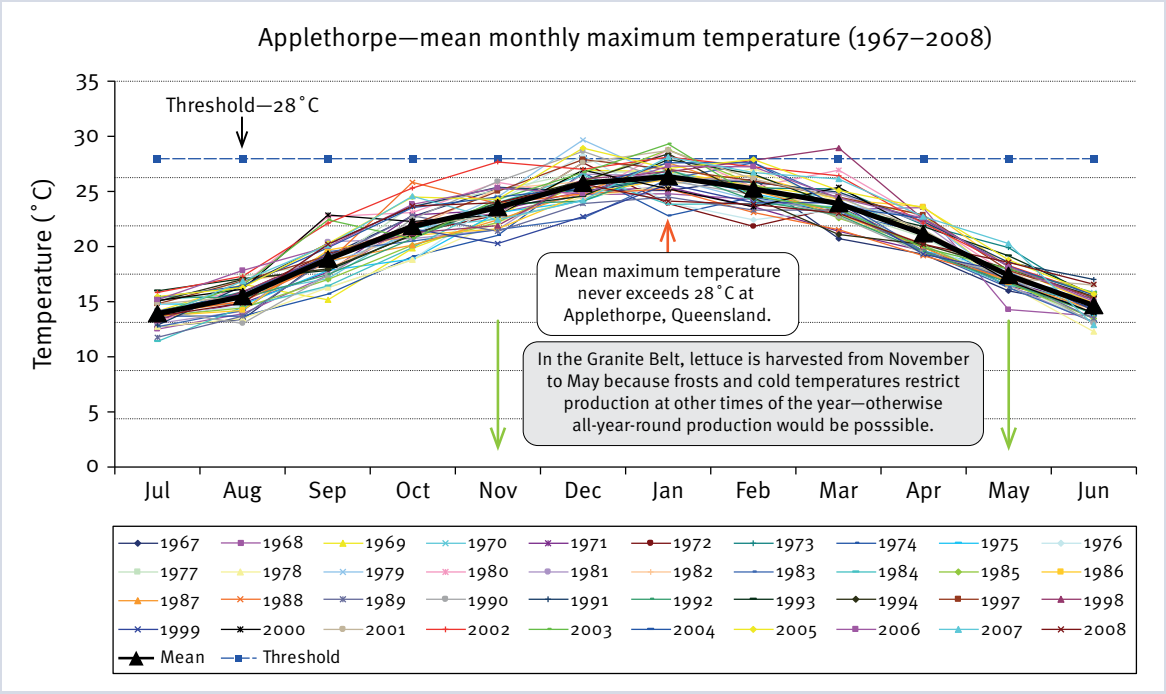


Figure 12.2 Mean monthly maximum temperatures—Applethorpe, Queensland

Production of lettuce in the Granite Belt, outside the summer season, does not occur because of the effects of frosts and low winter temperatures on product quality. There are no lettuce cultivars that can be grown in the winter and produce the same yield and quality as those grown in the summer.

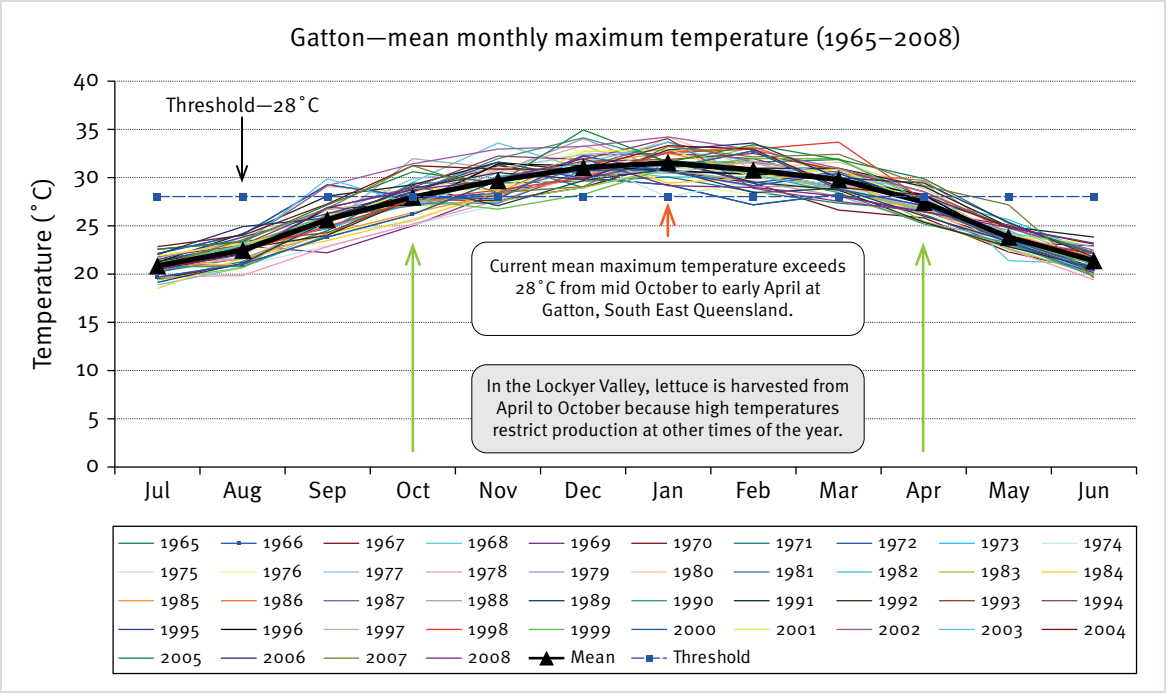


Figure 12.3 Mean monthly maximum temperatures—Gatton, Queensland

Intensive livestock

Current

Intensive animal production systems (cattle feedlots, piggeries, egg and meat chicken farms) are primarily located close to the eastern Darling Downs and Maranoa areas, as this provides secure access to appropriate water sources, grain and feed commodities, and required regional infrastructures. Meat chicken and egg production tends to occur in the Oakey, Toowoomba, Pittsworth, Millmerran and Warwick areas.

Piggeries are concentrated in the eastern Darling Downs area. There are significant piggery developments on the western side of the Great Dividing Range, extending into the Warwick area. There are piggeries located throughout the region, including areas surrounding Goondiwindi and the area between Dalby and Miles.

Beef feedlots occur across the entire Darling Downs region, primarily within a corridor encompassing the Oakey, Dalby, Miles and Roma areas. There are a number located in the south of the region along the New South Wales and Queensland border, with a major operation located near Texas.

Aquaculture is limited to a single location south-west of Chinchilla.

The total land area used exclusively for intensive animal production is 0.13 per cent; however, dry and/or irrigated cropping lands and grazing lands are usually attached to these production systems to facilitate sustainable waste stream re-use and access to feed.

Potential

Intensive animal production can potentially occur in a large area of the region. Of the Darling Downs region, 57 per cent has been identified as suitable for intensive livestock production (see Table 12.2 and Map 12.10). Intensive livestock production requires access to reliable and adequate supplies of water, grain and fodder from surrounding production areas, and relatively good access to skilled labour. Without access to these key inputs, the potential is limited.

The production infrastructure for intensive livestock facilities are preferably located on less-productive land types, with neighbouring (or adjacent) productive lands being used for disposal of animal waste streams to allow beneficial re-use of nutrients required for cropping. It is considered to be an ideal circumstance if potentially less-productive agricultural land that is surrounded by potential cropping land is used for intensive animal production.

Regional infrastructure for the safe transport of cattle, commodities and staff are key requirements of the sector. There are no commercial pig or poultry abattoirs located on the Darling Downs that operate for domestic or export supply. There are, however, two large commercial domestic/export cattle abattoirs located around the eastern and southern areas of the region, which focus on processing grain-fed cattle for the export market. Most cattle and all meat chickens (fit for slaughter) are transported to South East Queensland abattoirs. Pigs are primarily transported to the South Burnett or interstate for slaughter.

A number of large egg processors are based around the Millmerran, Pittsworth and Oakey areas, and are supplied through a network of egg producers in the region that primarily supply the caged, barn-laid and free-range egg markets.

Potential niche boutique production systems do exist in the region (e.g. lamb feedlots, duck meat and duck egg farms). However, due to the volatility of the markets they service, these production systems will potentially remain small.

Access to reliable, good-quality water supplies is essential to the development of the intensive livestock industry. The model codes of practice across all intensive livestock industries require that animals have ready access to good-quality drinking water. Animals must not be deprived of water for greater than 24 hours and water temperature should be maintained to ensure consumption is not refused. Poorer quality water can be utilised for cleaning and disinfection purposes; however, drinking water quality needs to be tested regularly for salt and mineral content, and microbiological contamination.

Grazing

Current

The opportunity and current use across the landscape for grazing are matched in terms of land area. Grazing occurs across all land potential classes, and unless land is used for other purposes it is considered to be used for grazing. The dominant areas that are best for grazing occur across the Balonne catchment and along the Condamine River vicinity. These areas are interspersed with broadacre cropping activities. Otherwise, land types that are better for grazing occur in patches across the region.

The whole region is used at times for sheep grazing where wild dog control is adequate. This occurs when demand is strong and sheep prices are rising, which has been the case recently.

Potential

Refer to Maps 12.11, 12.12 and 12.13 for an illustration of the different levels of grazing potential in the Darling Downs region. These maps show that there is only marginal potential to upgrade pasture production from current levels—mostly through increasing productivity of existing pasture lands.

The area between Miles and Moonie shows an extensive area of high pasture potential. Land condition B[15] reflects general or average management practices, and even under these conditions there is a high potential for pasture growth in this area. With improved management practices, the potential for annual pasture growth for this area is improved considerably. Existing sown pastures and potential for sown pastures are also considerable for this area. Sown pastures currently exist on nearly 6 million hectares (36 per cent of the region) and an additional 3.3 million hectares (19 per cent of the region) is suitable for sown pastures.

The area to the north of the region is an important grazing area with considerable potential in annual pasture production. The area also has potential for pasture improvement and sown pastures, which will improve productivity.

High potential for native pastures and high levels of sown and improved pastures shows that conditions in this area are favourable for supporting existing grazing production and expansion where possible.

To increase cattle production in the region there needs to be associated improvements to pasture and grain production, or increased use of feedlots. Map 12.13 shows the level of sown pasture on the Darling Downs. Due to the long tradition of grazing in the region, there is a history of pasture improvement. There are only small areas of the region that are not currently sown or are unsuited to sown pastures.

Stocking density is not assessed as part of the audit. It is considered an individual business decision. However, to manage climate risks and maintain productivity in the long term, it is important to adopt best management practice when determining stocking density.

The area to the west of Roma is characterised by a different bioregion—the mulga area. Due to the modeling methods used, this area appears less productive on the grazing maps than the surrounding area. This is highlighted in the map due to the grazing thresholds used.

15 Grazing land management land condition B is grazing land in 'fair' condition as defined at ‹http://futurebeef.com.au/topics/grazing-land-management/land-condition/›.

Forestry

Current

Darling Downs is an important forestry production and timber processing region for Queensland. The region generates approximately 80 per cent of Queensland's native cypress forestry production, 5–10 per cent of native hardwood forestry production and less than 5 per cent of plantation softwood forestry production for the Queensland timber processing industry.

Forestry production predominately comes from timber resource areas (native and plantation) on state-owned lands under the *Forestry Act 1959*, native forest practice notification areas on private (freehold) land under the *Vegetation Management Act 1999*[16] and plantation forestry areas on private land. Most forestry lands are also grazed and generally managed as silvopastoral systems—production systems that combine forestry and grazing in a mutually beneficial way.

Native forestry, predominately cypress and hardwood, produces a range of forest products including sawlogs, poles, bridging girders, fencing timbers and craftwood for a broad range of appearance, construction and mining timber processing purposes. Hardwood fencing timbers are an important resource for grazing and other agricultural land uses. Native forestry currently occurs right across the region, generally on land that is also used for grazing. The key commercial native forestry tree species on the Darling Downs include white cypress pine, spotted gum, ironbark, Queensland blue gum and box, plus a broad range of other suitable species.

Native forestry occurs on state-owned land and private land. On state-owned land, the denotation of a management unit (MUID)[17] 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. There are currently timber interests based on MUIDS on 2.469 million hectares (14.74 per cent of the region), recognising that this figure is not the actual area of native forestry production on state land (see Table 12.3). Harvesting of these MUIDS is scheduled on a routine basis in conjunction with the current state timber supply commitments and market demand.

On private land (freehold), native forestry forest practice notifications (managing, felling and removal of native trees for commercial purposes) cover over 1.053 million hectares (6.29 per cent of the region). The actual area of production is generally restricted to the forested areas within the lot on plan (see Table 12.3).

Plantation forestry, including softwood and hardwood, in the region is relatively modest in comparison to other Queensland regions (mostly coastal) and currently occurs on 13 106 hectares (0.08 per cent of the region). Hardwood plantation forestry areas cover 2452 hectares, which are generally managed as silvopastoral systems. Softwood plantation forestry areas cover 9647 hectares and have a denser tree canopy. They generally only combine with grazing for around the first 5 years of a crop rotation until tree canopy closure.

Plantation forestry produces a number of forest products including sawlogs, round timbers and pulpwood for a broad range of appearance and construction timber purposes. Plantation forestry in the region is relativity modest due the region's mostly 'lower' rainfall in comparison to the coastal areas of Queensland. However, the region includes four medium-sized softwood plantation forestry estates—exotic pine around Stanthorpe, Warwick and north of Toowoomba; and native hoop pine near Yarraman. There are also some small hardwood plantations in the region, mostly east and north of Chinchilla and Dalby.

16 Under the *Vegetation Management Act 1999*, 'forest practice' includes felling and removing trees for commercial gain. A landholder who conducts a native forest practice on remnant vegetation must do so according to the *Code applying to a native forest practice on freehold land* and must give formal notice of the location through a 'Notice of a forest practice' form.

17 MUID—management unit inventory data.

Most of the softwood plantations were established by the Queensland Government for sawlog production from the 1960s to the 1990s. The majority of the hardwood plantations were established since late 1990s by both the Queensland Government and private investors. The plantation forestry estates on state-owned land were licensed, and on freehold land sold, to private interests in 2010 by the Queensland Government.

The softwood plantation tree species are exotic pine varieties that perform well across a range of soils, particularly less-fertile soils that receive annual average rainfall of greater than 800 mm for 7 out of 10 years, and native hoop pine that performs well on the more fertile soils that receive an annual average rainfall of greater than 700 mm for 7 out of 10 years. Hardwood plantation forestry tree species are mostly spotted gum and some Chinchilla (western) white gum. Most of the hardwood plantings in the region are relatively new and (due to drought, pest and disease attack) have a question mark over them regarding their commercial performance at this stage.

There are a number of large, medium-sized and small timber processing facilities within and outside the region, sourcing the region's native cypress and hardwood forestry products. There are also a number of portable sawmills and fencing timber processors servicing the region's forestry production that are not mapped. Cypress sawmills are located right across the region—Cecil Plains, Chinchilla, Inglewood, Injune, Miles, Mitchell, Mungallala, Roma and Yelarbon. Queensland's largest hardwood sawmill is located at Wandoan, and a number of other medium-sized processors are just outside the region. Commercial haul distances can be 400 km or more, although will vary in line with the value of the product.

Forest products from the native hoop pine and exotic pine plantations near Yarraman and Toowoomba are mostly processed outside the region, as both are on the eastern boundary of the region and help supply resources to more centrally located regional softwood timber processors. The exotic pine forestry plantation around Stanthorpe is mostly processed by a local softwood timber processor at Stanthorpe. Hardwood plantations in the region are presently immature and expected to come onstream for harvest after 2025.

Potential

There is potential for increased hardwood and softwood forestry production in the region, particularly native cypress and native hardwood, but also some hardwood plantation. Increased forestry production would provide further resource for existing timber-processing facilities inside and near the region once increased supply comes onstream. However, for hardwood plantation forestry the high risk of some species of pest/disease damage will need to be carefully considered given the recent experience with hardwood plantations in the region. Increased forestry production would provide further resource for existing timber processing facilities inside and near the region once increased supply comes onstream.

Forestry production is currently operating in some of the potential areas —in others, potential production is yet to be realised. While the native forestry mapping is reasonably accurate, it is primarily based on the regional ecosystem mapping data used for the *Vegetation Management Act 1999*. As such there are some identified inaccuracies.

The potential high, medium and low production areas identified for native forestry expansion on the Darling Downs are considerable—over 1.881 million hectares for high potential production, over 2.005 million hectares for medium potential production and over 2.398 million hectares for low potential production (11.23, 11.97 and 14.97 per cent respectively of the region's area). The better opportunities for native forestry expansion are generally associated with areas that are predominately grazing land where commercial native tree species are present but haven't been actively managed as silvopastoral systems.

The plantation forestry mapping shows the majority of the region's softwood and hardwood plantations growing outside the potential plantation projected areas. This is due to the limitations of the rainfall measurement recording stations.

The potential area identified for plantation forestry expansion on the Darling Downs is generally limited to higher rainfall areas—hardwood 32 473 hectares and softwood 4535 hectares (0.19 and 0.03 per cent respectively of the region's area) (Map 12.15). The current land uses for potential hardwood plantation areas are grazing (75 per cent), mixed forestry (13 per cent) and other uses (12 per cent). For potential softwood plantation areas, the existing land uses are grazing (69 per cent), other non-agricultural uses (22 per cent) and other agricultural land uses (9 per cent).

Spotted gum (hardwood) varieties are considered the best potential forestry plantation performers for expansion given the results of research trials in the region. Hardwood plantation forestry expansion has the advantage of being able to be integrated into the existing grazing landscape (particularly with spotted gums and similar tree varieties) by being managed as silvopastoral systems.

The region is considered stable for further plantation forestry development, with:

- some areas with good rainfall (in the areas mapped as potential)
- low risk of severe cyclones
- productive growth rates for plantation spotted gum hardwood species (in the areas mapped as potential)
- relatively affordable land prices
- potential access to a broad range of existing timber processing facilities and the domestic markets of Toowoomba and South East Queensland.

Most existing timber processors in the region have some capacity to expand production if increased log timber becomes available. Demand for native hardwood forest products is high and native cypress forest products is medium. Demand for forest products is forecast to remain strong in the medium to long term.

Overall, the region is an important forestry production and timber processing region for Queensland. There is considerable opportunity for production growth in native cypress and hardwood forestry and some hardwood plantation forestry, which in turn will support growth in the downstream timber processing sector.

Table 12.3 Current and potential land area for forestry (hectares)

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	2 452	0.01	5.87	32 473	0.19
Softwood	9 647	0.06	4.59	4 535	0.03
Mixed species (softwood and hardwood)	26	0.00	8.72	0	0.00
Fallow (where plantation not currently planted to trees)	982	0.01	5.61		
Total	**13 106**	**0.08**		**37 009**	**0.22**
Native forestry					
State-owned land timber interests (area based on entire lot on plan, forestry restricted to forested area within that)	2 469 292[§]	14.74			
Private land (native forest practice notifications)	1 053 526	6.29			
High potential				1 881 322	11.23
Medium potential				2 005 549	11.97
Low potential				2 398 168	14.31
Total	**3 522 818**	**21.03**		**6 285 039**	**37.51**

[*] Potential areas includes where the majority of current production occurs as well as where production could potentially occur. Refer to Section 12.3 ('Data confidence').

[†] 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 (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.

12.3 Data confidence

The data confidence map (see Map 12.16) indicates that the agricultural land class dataset used as the basis for most of the maps developed for the Darling Downs region (excluding grazing and forestry) was considered a low confidence level.

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.

On the Darling Downs there is low confidence that if you go to the actual site represented on the map, it will match the agricultural land class assigned to that area.

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 photos. As there are difficulties with differentiating land uses using imagery, local expert knowledge and some field surveys have been conducted to verify the data.[18]

The current locations 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 area for intensive land use is based on QLUMP data. 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). The location of egg production is based on the Safe Food Production Queensland egg register as at October 2012.

Apart from forestry and intensive animals (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 (see Table 12.2). 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 12.3.

As there will be differences between the current Intensive Livestock Environmental Regulation Unit 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 it is 2009 data), 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 had 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 12.2 overestimate the true potential area for each agricultural land-use category.

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

12.4 Sources of information

12.4.1 Bibliography

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Australian Bureau of Statistics 2012, 7503.0—Value of Agricultural commodities: small area data, Australia, 2010–11, Australian Bureau of Statistics, Canberra.

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Department of Agriculture, Fisheries and Forestry 2012, ‘Queensland Agricultural Land Audit’, unpublished data.

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Queensland Government 2012, ‘Great Artesian Basin water resource planning’, Queensland Government, viewed 4 October 2012, ‹http://www.derm.qld.gov.au/wrp/gab.html›.

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State of Queensland 2003, *Water Resource (Border Rivers) Plan 2003,* Office of the Queensland Parliamentary Counsel.

State of Queensland 2003, *Water Resource (Moonie) Plan 2003,* Office of the Queensland Parliamentary Counsel.

State of Queensland 2004, *Water Resource (Condamine and Balonne) Plan 2004,* Office of the Queensland Parliamentary Counsel.

State of Queensland 2007, *Water Resource (Mitchell) Plan 2007,* Office of the Queensland Parliamentary Counsel.

The University of Queensland 2011, ‘Darling Downs’, The University of Queensland, viewed 8 October 2012, ‹http://queenslandplaces.com.au/node/266›.

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12.4.2 Further studies

Pre-amalgamation shire handbooks

- Balonne Shire (1973)
- Waggamba Shire (1971)
- Waggamba Shire (1980)
- Inglewood Shire (1970)
- Bendemere Shire (1971)
- Booringa Shire (1973)
- Bungil Shire (1971)
- Warroo Shire (1971)
- Allora Shire (1971)
- Glengallan Shire (1972)
- Rosenthal Shire (1973)
- Stanthorpe Shire (1972)
- Cambooya Shire (1972)
- Clifton Shire (1972)
- Crow's Nest Shire (1972)
- Jondaryan Shire (1977)
- Millmerran Shire (1970)
- Pittsworth Shire (1970)
- Rosalie Shire (1972)
- Chinchilla Shire (1971)
- Murilla Shire (1970)
- Tara Shire (1971)
- Wambo Shire (1969)

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).

***Beckmann, GG & Thompson, CH 1960. *Soils and land use in the Kurrawa area, Darling Downs, Queensland*, soils and land use series no. 37, CSIRO, Queensland, 76 pp.**

Abstract: The Kurrawa area discussed covers about 530 square miles in the central western part of the Darling Downs and consists of two very different classes of country. The electronic version has links to a soils map.

Cummins, VG, Robinson, IB, Pink, HS & Roberts MH 1973, *A land use study of the Wyreema–Cambooya area of the eastern Darling Downs*, technical bulletin no. 10, Queensland Department of Primary Industries, 163 pp.

Abstract: This is a report on a pilot study to devise techniques to document the land resources of the eastern Darling Downs in general, and of the basaltic uplands in particular. The study was orientated towards an examination of the erosion situation with a view to identifying desirable changes in land use. This bulletin describes the methods used to document the physical resources and, in addition, explores some of the economic effects of these changes on farming enterprises in the area.

***Dawson, NM 1972, *Land inventory and technical guide, Jandowae area, Queensland—part I: land classification and use*, technical bulletin no. 3, Queensland Department of Primary Industries, 58 pp.**

Abstract: This survey is the first of a series proposed within integrated districts in Queensland, and has been designed to provide broad information on the land-use potential within the Jandowae area for planning and development purposes. The electronic version has links to spatial data.

***Dawson, NM 1972, *Land inventory and technical guide, Miles area, Queensland—part I: land classification and use*, technical bulletin no. 5, Queensland Department of Primary Industries, 117 pp.**

Abstract: The land resources of the Miles area (comprising 1.38 million hectares) were classified to provide a basis for land-use planning and development of effective agricultural research and advisory programs. The report discusses the important physical and chemical characteristics of 36 soil series and their effects on land use, and 20 vegetation communities have been discussed in terms of their distribution and structural form. The electronic version has links to maps for vegetation, land systems and land capability.

Department of Natural Resources and Mines 2001, *Soils survey of the eastern Darling Downs*, State of Queensland.

Abstract: This resource includes three soils maps of the Clifton, Warwick and Oakey areas.

Galloway, RW 1974, *Lands of the Balonne–Maranoa area, Queensland*, land research series no. 34, CSIRO, Queensland, 253 pp.

Abstract: Information on the lands of the Balonne–Maranoa area has been collated at three different levels of detail—land unit, mapping unit and land system.

Gray, HJ & Macnish, SE 1985, *Land management field manual, Wandoan district*, land management field manual QE85006, Department of Natural Resources, Mines and Energy, Queensland, 160 pp.

Abstract: This Wandoan field manual is one of a series of manuals detailing the recommended land management practices for the major cropping areas of Queensland.

Harris, PS, Biggs, AJW & Coutts, AJ 1999, *Central Darling Downs land management manual: understanding and managing land in Wambo, Pittsworth, Rosalie, Millmerran, Jondaryan shires, Dalby town and Toowoomba city*, DNRQ990102, Department of Natural Resources, Queensland, 197 pp.

Abstract: This land management manual is a collation of currently available land resource data, combined with local knowledge and experience, primarily concerning soils and their management. The manual discusses the attributes and limitations of the soils used for primary production for some 2.6 million hectares in the shires of Millmerran, Pittsworth, Jondaryan, Toowoomba, Rosalie and Wambo.

Isbell, RF 1957, *The soils of the Inglewood–Talwood–Tara–Glenmorgan region, Queensland*, technical bulletin no. 5, Bureau of Investigation, Department of Public Lands, Queensland, 123 pp.

Abstract: This report describes a comprehensive reconnaissance soil survey of approximately 8500 square miles in southern Queensland and includes two maps.

***Macnish, SE 1979, *Land evaluation of an area of basaltic soils near Pittsworth on the eastern Darling Downs*, technical bulletin no. 36, Department of Natural Resources, Queensland, 89 pp.**

Abstract: Climate, vegetation, geology, soils and land use were investigated in an area of basalt soils supporting predominantly softwood scrub and layered open forest vegetation in part of the Linthorpe and Ashall Creek catchments on the eastern Darling Downs. The soils were compared with those supporting grassy open forest and open woodland vegetation in the surrounding basaltic uplands region. The electronic version has links to five maps.

Macnish, SE 1987, *Land management field manual Roma district*, land management field manual QE87001, Department of Natural Resources and Mines, Queensland, 182 pp.

Abstract: This Roma field manual is one of a series of manuals detailing the recommended land management practices for the major cropping areas of Queensland.

Maher, JM 1996, *Understanding and managing soils in the Murilla, Tara and Chinchilla shires*, DNR Q96001, Department of Primary Industries, Queensland, 137 and 95 pp.

Abstract: This report includes resource information and a field manual. It is designed to increase the awareness and aid the understanding of land resources information within the community. It comprises maps and data for land resources and their management.

Maher, JM 1996, *Understanding and managing soils in the Stanthorpe–Rosenthal region*, training series QE96001, Department of Natural Resources, Queensland, 191 and 94 pp.

Abstract: This report includes resource information and a field manual. It is designed to increase the awareness and aid the understanding of land resources information within the community. It comprises maps and data for land resources and their management.

Marshall, JP, Crothers, RB, Macnish, SE & Mullins, JA 1988, *Land management field manual: south-east Darling Downs districts*, land management field manual QE88001, Department of Natural Resources, Mines and Energy, Queensland, 213 pp.

Abstract: This south-east Darling Downs field manual is one of a series of manuals detailing the recommended land management practices for the major cropping areas of Queensland.

***Mullins, JA 1980, *Land use study for the Millmerran–Moonie–Tara area of Queensland*, technical bulletin no. 41, Department of Natural Resources and Mines, Queensland, 114 pp.**

Abstract: The land resources of the Millmerran–Moonie–Tara area of south-eastern Queensland, comprising 972 500 hectares, were classified and mapped using the land system/land unit approach. The agricultural management requirements for the land resources were defined and described, and the area was mapped into 35 land systems. The land systems and component land units were described in terms of soil, vegetation, landform and land capability for agriculture. The electronic version has links to maps of land systems.

Reid, RE, Leverington, AR, Sorby, P & Baker, DE 1990, *Soils and land use characteristics of the Maranoa River Irrigation Area: Mitchell*, project report Q090006, Department of Natural Resources, Mines and Energy, Queensland, 53 pp.

Abstract: Data is provided on the irrigation potential of lands riparian to the Maranoa River from 15 km upstream of Mitchell to 14 km downstream. Of some 65 000 hectares initially appraised, 10 000 hectares was deemed as potentially irrigable and is the subject of this report. Mapping was carried out at 1:100 000 scale and 8183 hectares was identified as being suitable for irrigation with slight to severe limitations, the remainder being considered totally unsuitable. Soils ranged from deep siliceous sands on Maranoa River alluvium, solodic soils and brown or grey clays on local and higher lying alluvium, to brown and grey clays on cretaceous mudstones.

Ross, DJ & Crane, AJ 1994, *Land resource assessment of the Goodar area, Queensland*, land resources bulletin series QV94003, Queensland Department of Primary Industries, 126 pp.

Abstract: A soil survey and land suitability assessment have been undertaken to provide better information about soils, vegetation, landforms and land-use problems . This report describes the land resource and land suitability data for various classes of land. It also describes the soils and landscape units, geology, vegetation and climate of the area, as well as the methods used in the survey. The distribution of soils and various classes of land are shown on the accompanying maps. A plant species list and data for 53 soil profiles are appended.

***Thompson, CH & Beckmann, GG 1959, *Soils and land use in the Toowoomba area, Darling Downs, Queensland*, soils and land use series no. 28, CSIRO, Queensland, 80 pp.**

Abstract: This report includes an electronic link to a soil association map of the area represented by the Toowoomba 1-mile military sheet, which is representative of a large part of the basaltic uplands on the Darling Downs in south-eastern Queensland. An area of approximately 40 000 acres was covered by a detailed survey to establish and relate the component soil series of the more extensive associations. The electronic version has links to a soils map.

Thwaites, RN & Macinish, SE 1991, *Land management manual: Waggamba Shire*, training series QE90014, Queensland Department of Primary Industries, 89 pp.

Abstract: This report includes resource information and a field manual. It is designed as the primary reference section for the land resource areas, soils and management recommendations. It comprises maps, keys and summary data for land resources and their management.

***Vandersee, BE 1975, *Land inventory and technical guide, eastern Downs area, Queensland: land classification and land use*, technical bulletin no. 7, Queensland Department of Primary Industries, 76 pp.**

Abstract: The land resources of the eastern Downs area of south-eastern Queensland, comprising 1 320 700 hectares, were classified to provide a basis for land-use planning and the development of effective agricultural research and extension programs. The climate, physiography, drainage, hydrology and geology of the area are discussed in broad terms. The area has been mapped into 19 land systems and the land system and component land units are described. The electronic version has links to maps for land capability and land systems.

***Vandersee, BE 1978, *Cooyar grazing land study*, technical bulletin no. 34, Department of Natural Resources and Mines, Queensland, 65 pp.**

Abstract: The land resources of the Parish of Cooyar in south-eastern Queensland, comprising an area of approximately 72 000 hectares, were mapped and classified with particular emphasis on the grazing lands of the area. Approximately 56 000 hectares were classified as grazing land and mapped into 13 land systems. The resources of the area—including climate, geology, geomorphology, drainage, land systems, vegetation and soils—are discussed. Present land use is discussed and potential land use examined. The electronic version has links to a land systems map.

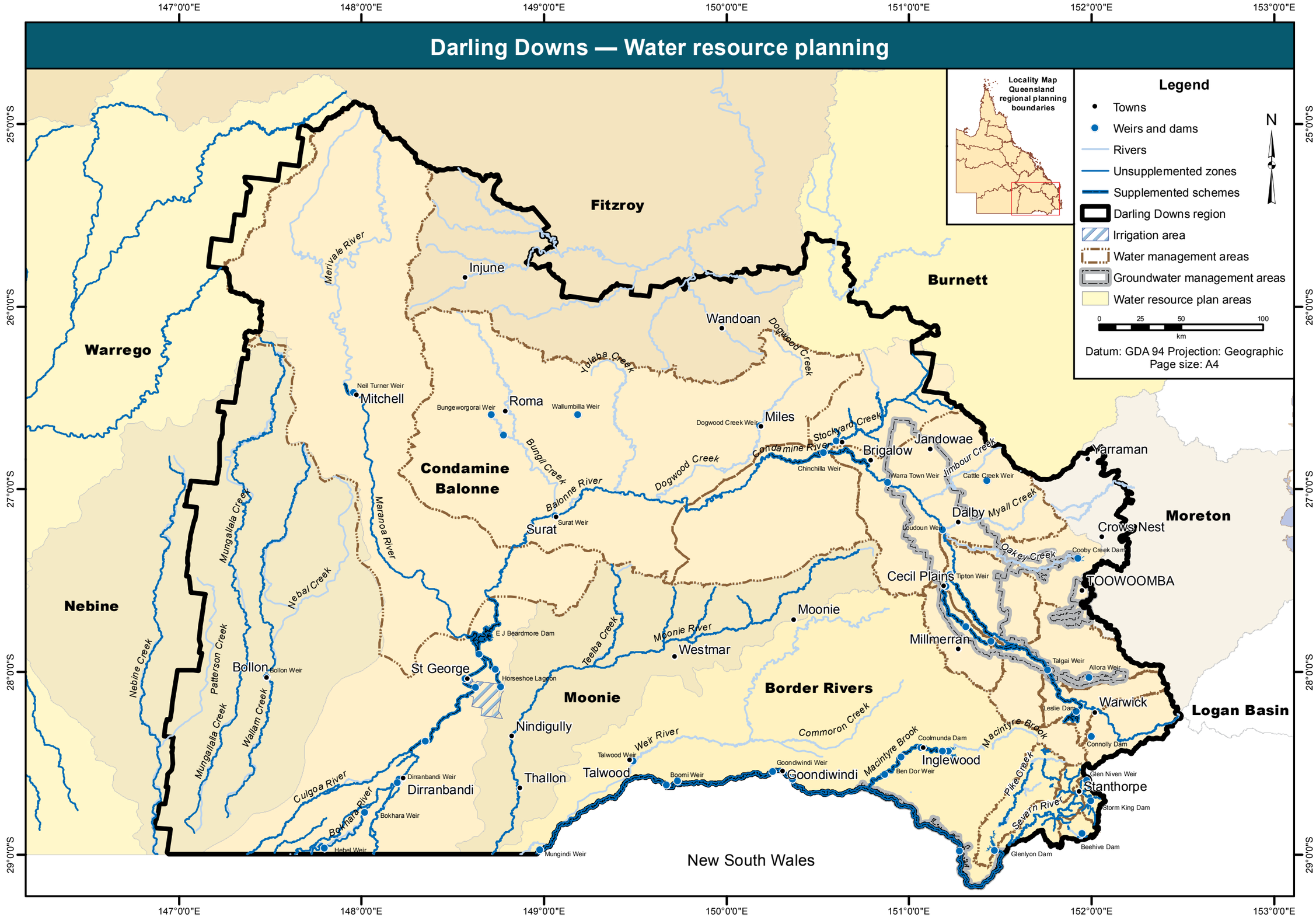
***Wills, AK 1976, *The granite and traprock area of south east Queensland: a land inventory and land utilisation study—part II: land utilisation*, technical bulletin no. 13, Queensland Department of Primary Industries, 182 pp.**

Abstract: This reports on a survey of existing land use associated with agriculture, horticulture, pastures, livestock, apiculture and forestry. The electronic version has links to maps for climate, soils and land systems.

Map 12.2 Water resources

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

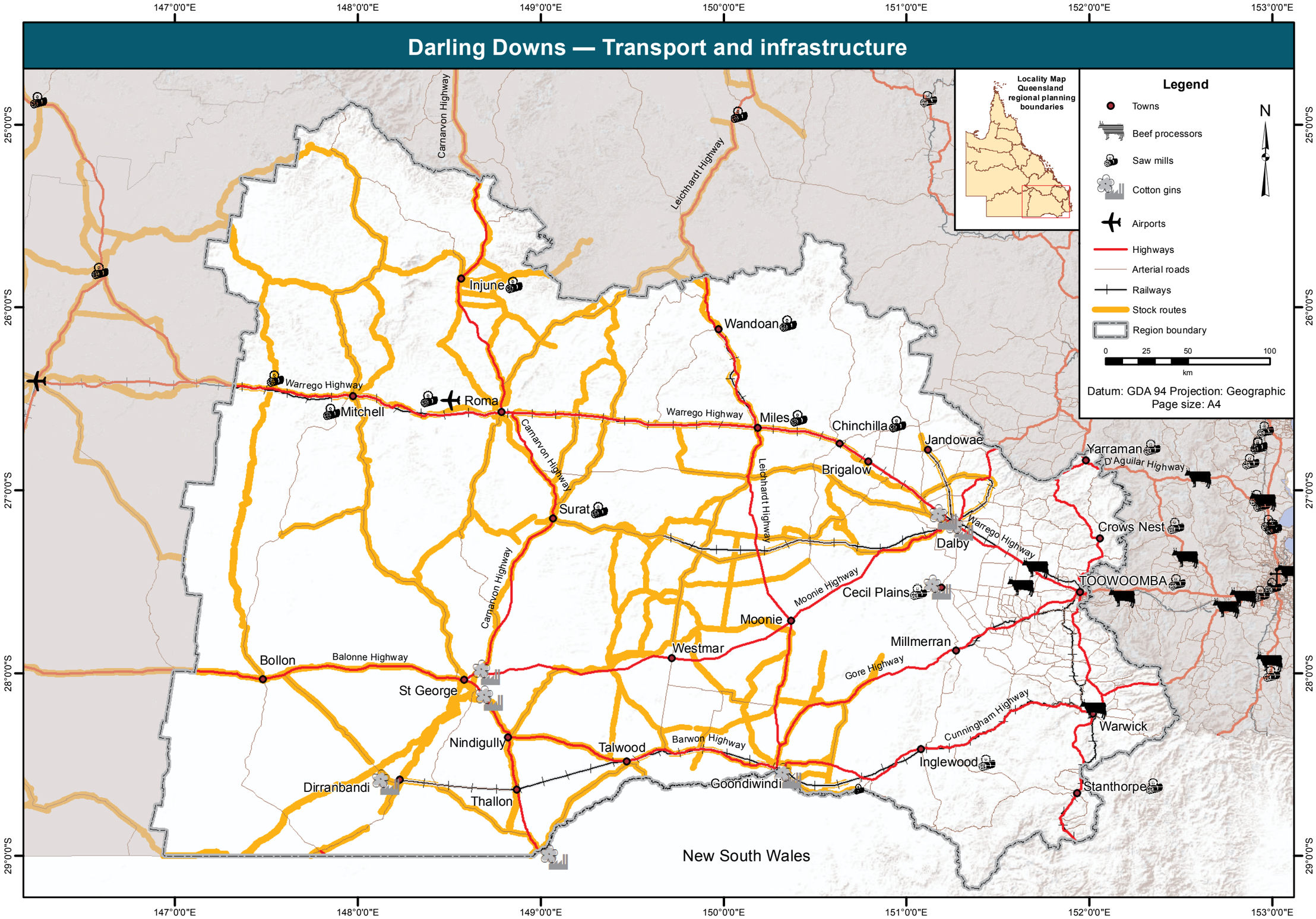
Darling Downs — Water resource planning



Map 12.3 Infrastructure

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

Darling Downs — Transport and infrastructure



Map 12.4 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:

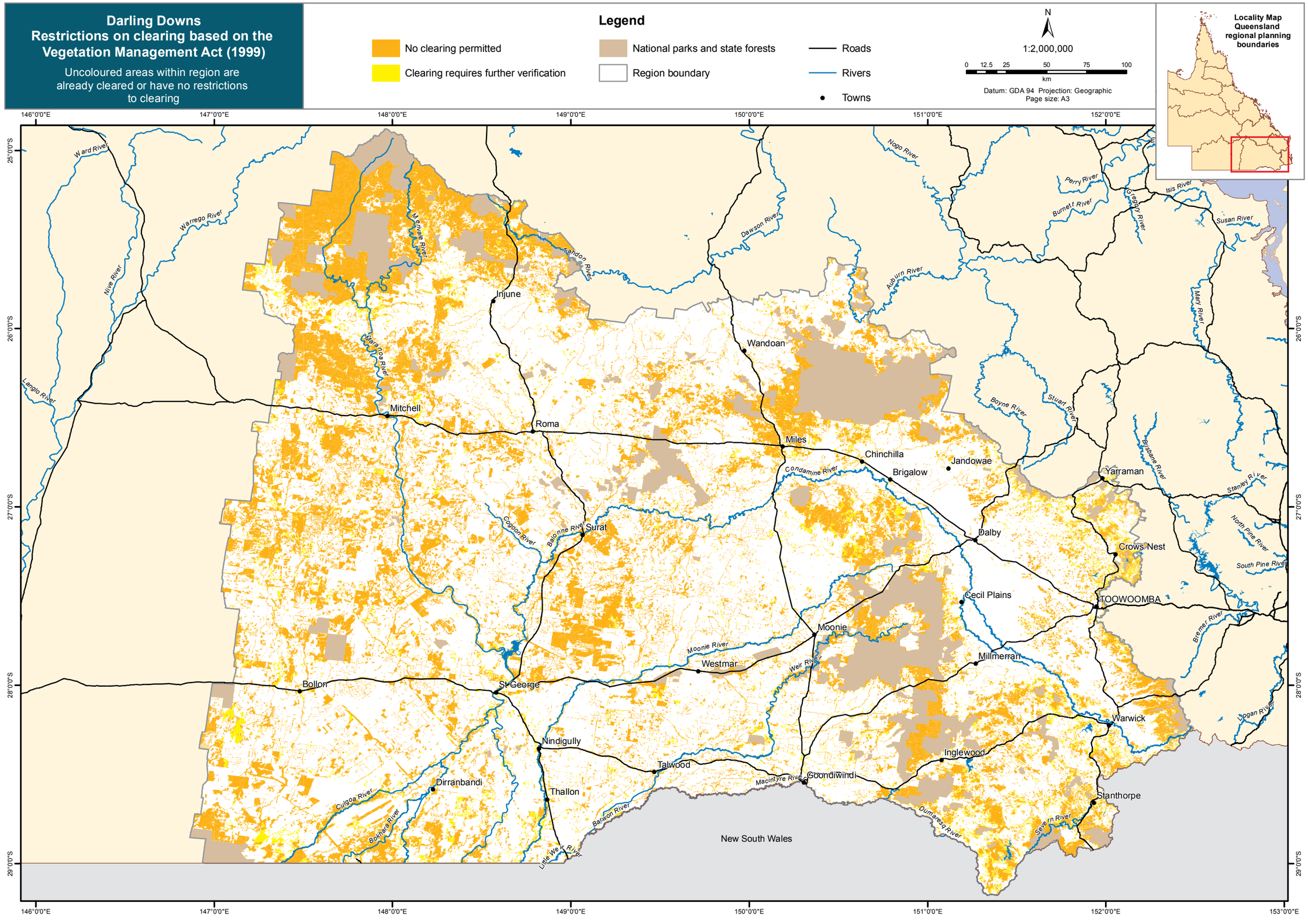
- remnant vegetation other than Schedule 4 Grasslands on the regional ecosystem map

and

- category A or B on a PMAV.

Darling Downs
Restrictions on clearing based on the Vegetation Management Act (1999)

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



Map 12.5 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 2006 (with some small areas current as at 1999 and 2009). 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.

Darling Downs
Current land use based on QLUMP data (2006) and other data sources for forestry (see explanatory notes)

Legend

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

N

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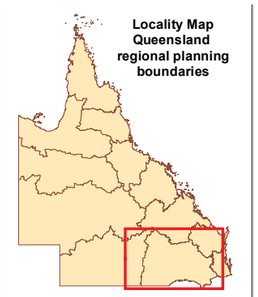
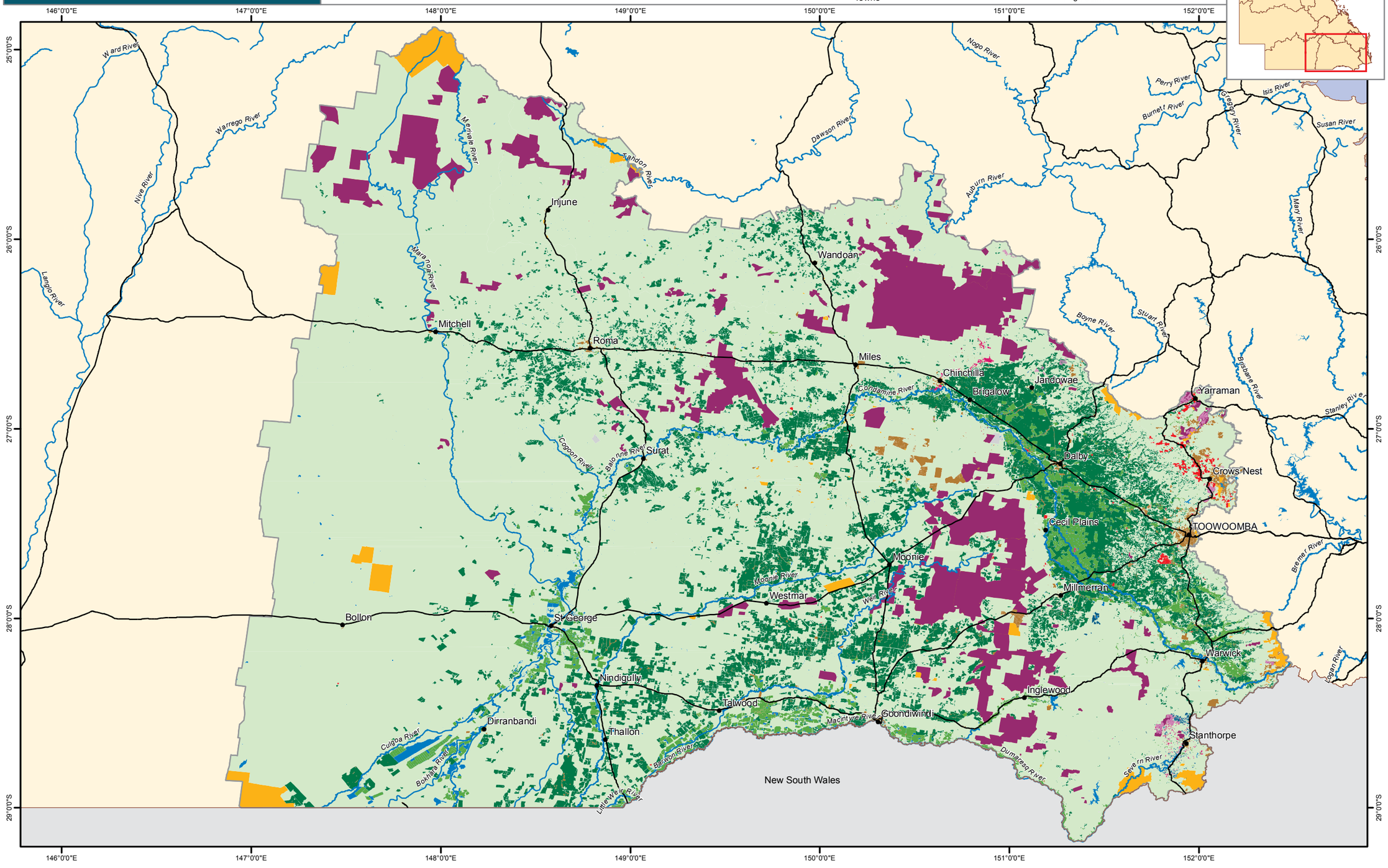
0 12.5 25 50 75 100 km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries





Map 12.6 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.

Darling Downs
Important agricultural land areas

Legend

- Northern Darling Downs / Injune
- Eastern Darling Downs
- Granite Belt
- Border Region
- Areas excluded from potential (see explanatory notes)
- Region boundary
- Roads
- Rivers
- Towns

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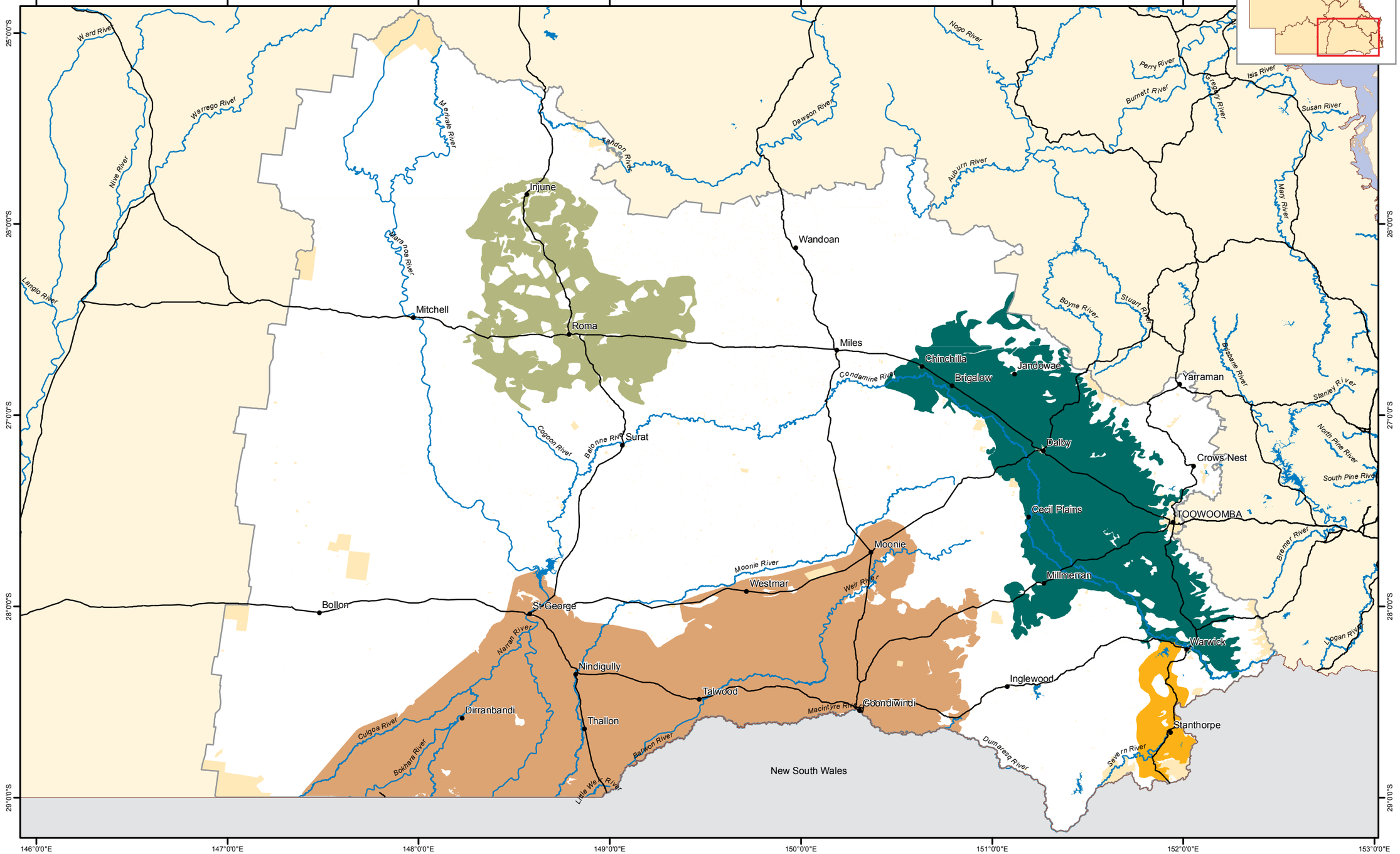
0 12.5 25 50 75 100
km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 12.7 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 12.2). See Section 12.1 for further constraints.

Darling Downs
Biophysical potentialfor broadacre cropping and current broadacre cropping

Porential 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)
- Region boundary
- Cotton gins
- Roads
- Rivers
- Towns

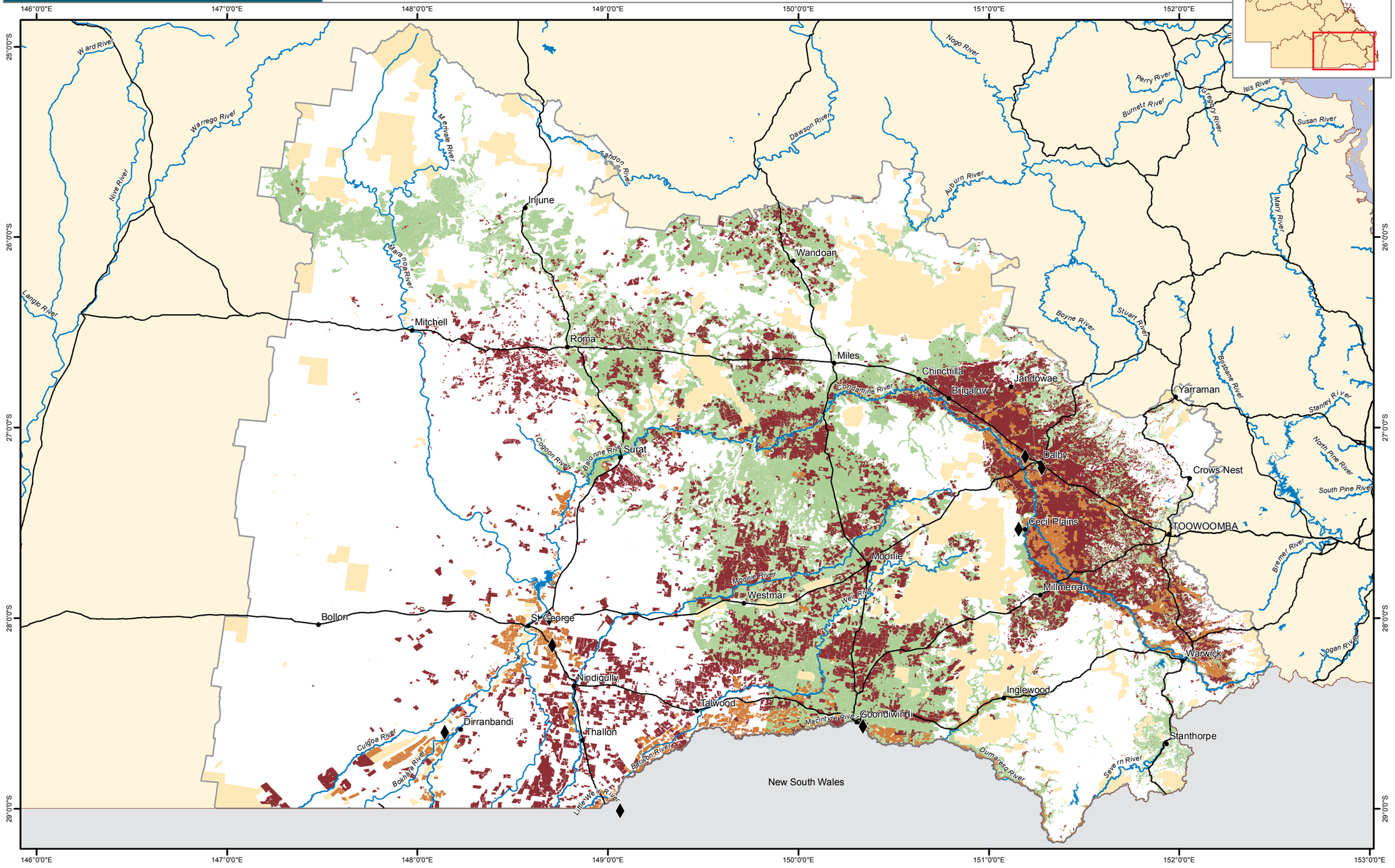
N

1:2,000,000

0 12.5 25 50 75 100 km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 12.8 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 mean annual rainfall less than 1000 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 12.2). See Section 12.1 for further constraints.

Darling Downs
Biophysical potential for annual horticulture and current annual horticulture

Potential based on ALC 'A' and 'B', slope <8%, mean annual rainfall <1000mm

Legend

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

N

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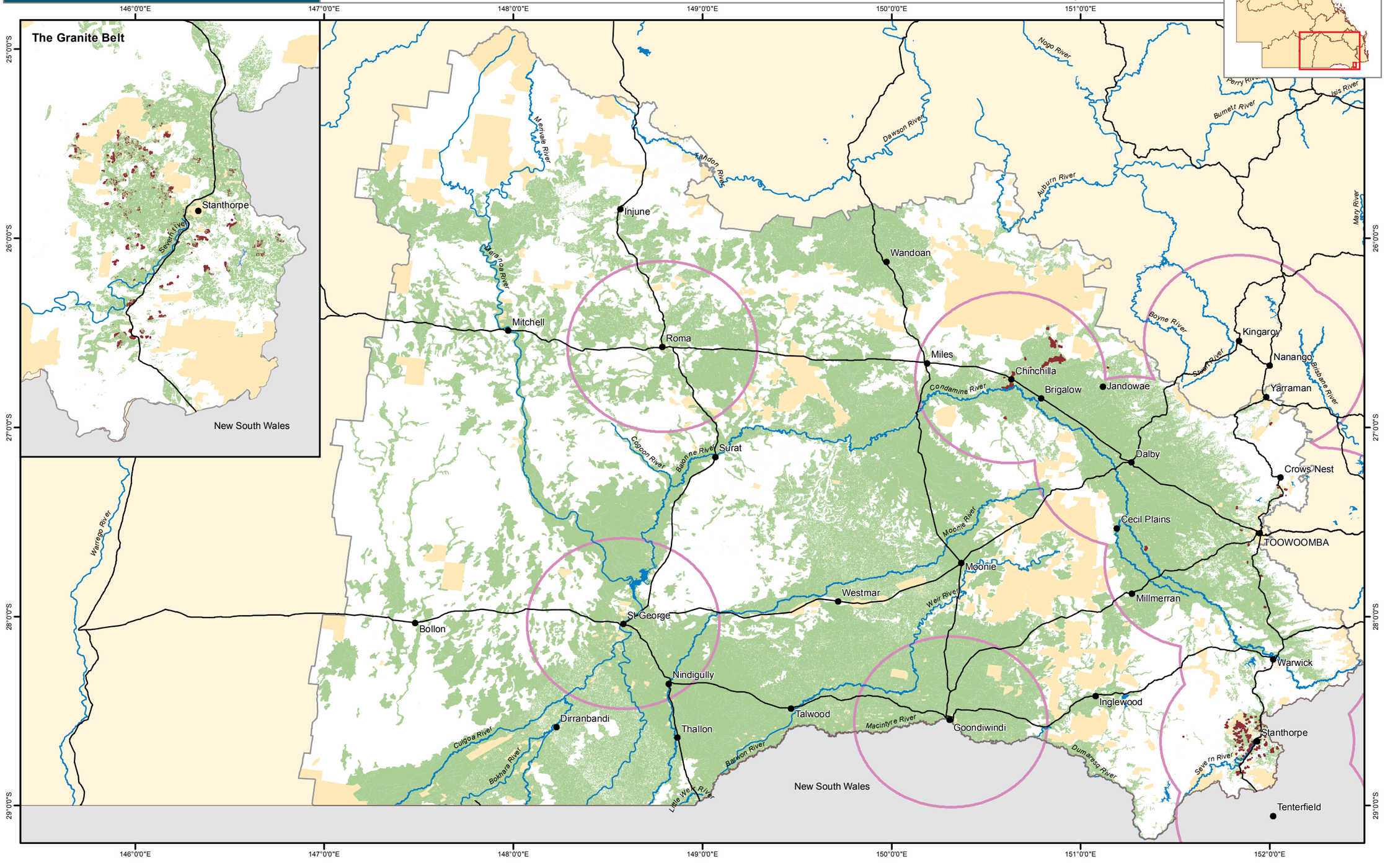
0 12.5 25 50 75 100 km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 12.9 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 mean annual rainfall less than 1000 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.

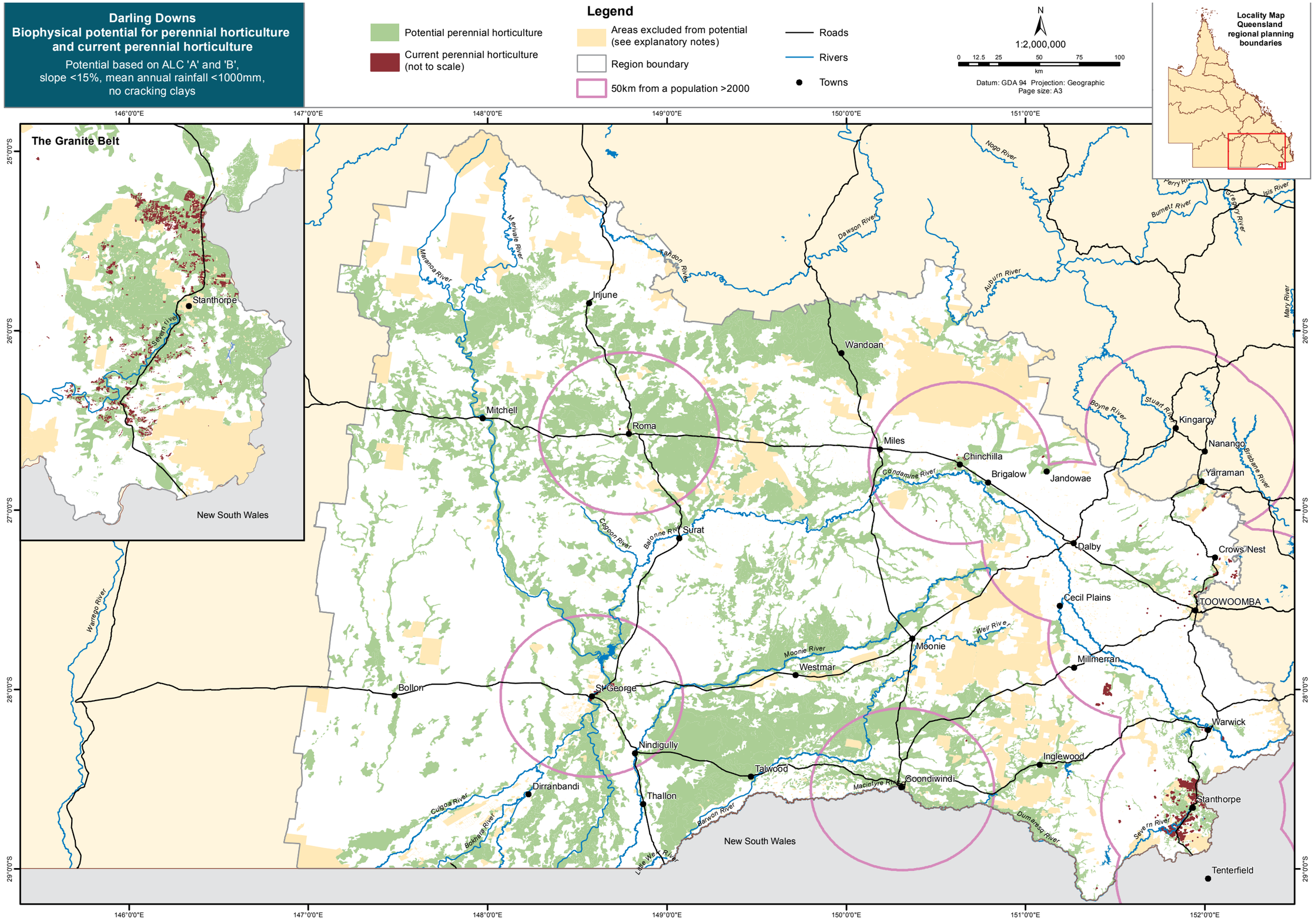
Also, the audit **did not consider** temperature or flood risk. Temperature is a major determinant of suitability of land for horticulture. It affects whether a crop can grow and its performance. However, due to the large range of different horticultural crops grown in Queensland and the widely variable 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 12.2). See Section 12.1 for further constraints.

Darling Downs
Biophysical potential for perennial horticulture and current perennial horticulture

Potential based on ALC 'A' and 'B',
slope <15%, mean annual rainfall <1000mm,
no cracking clays



Map 12.10 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 and pork 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 and pig 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 12.2) and natural resource regulations such as those for vegetation management.

Darling Downs
Biophysical potential for cattle feedlots and piggeries and current intensive animal production

Feedlots and piggeries potential: 'A' + 'B' class land + 'C1' class land within 10km of current cropping, slope ≤8%

Legend

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

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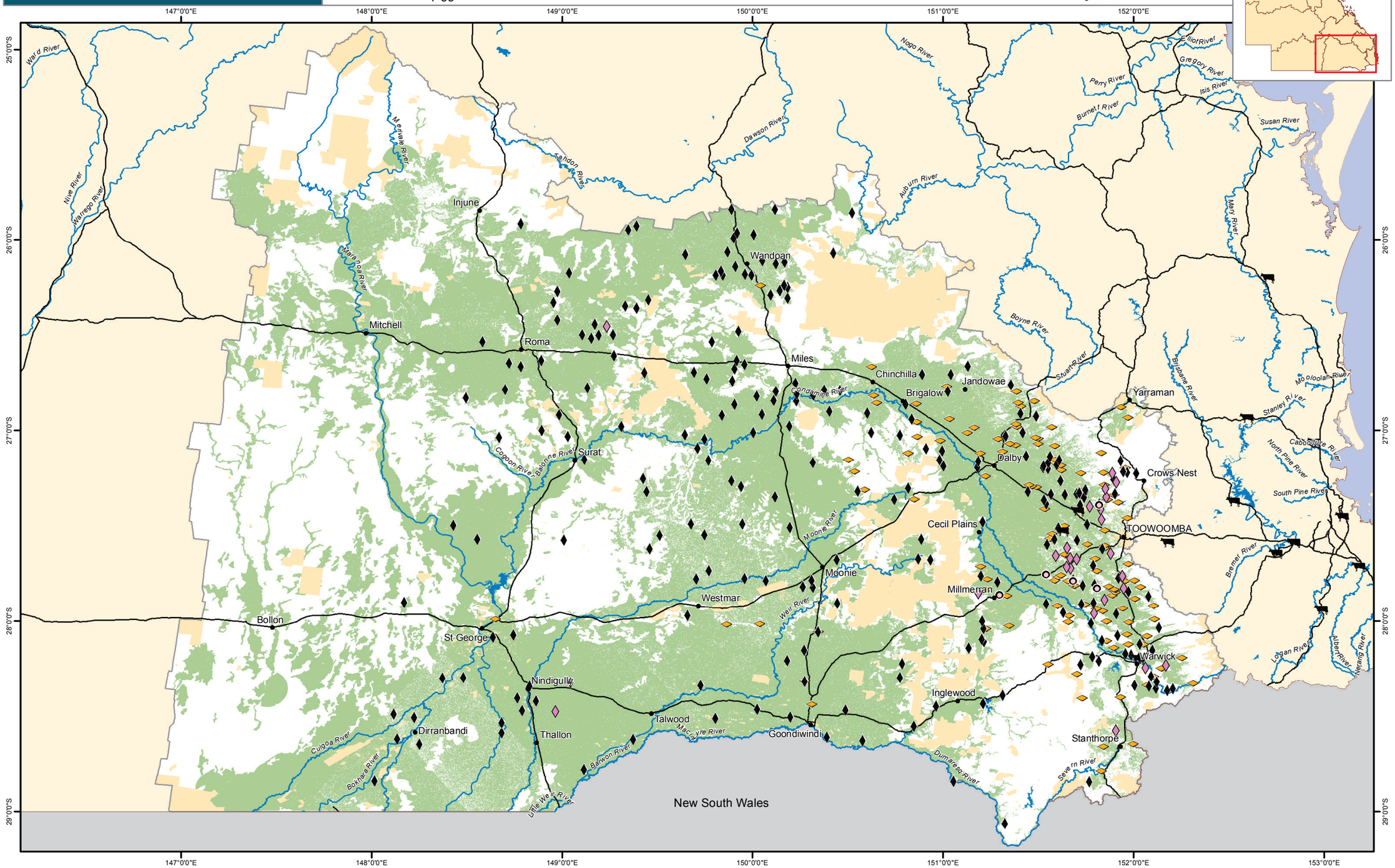
0 12.5 25 50 75 100

km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 12.11 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)

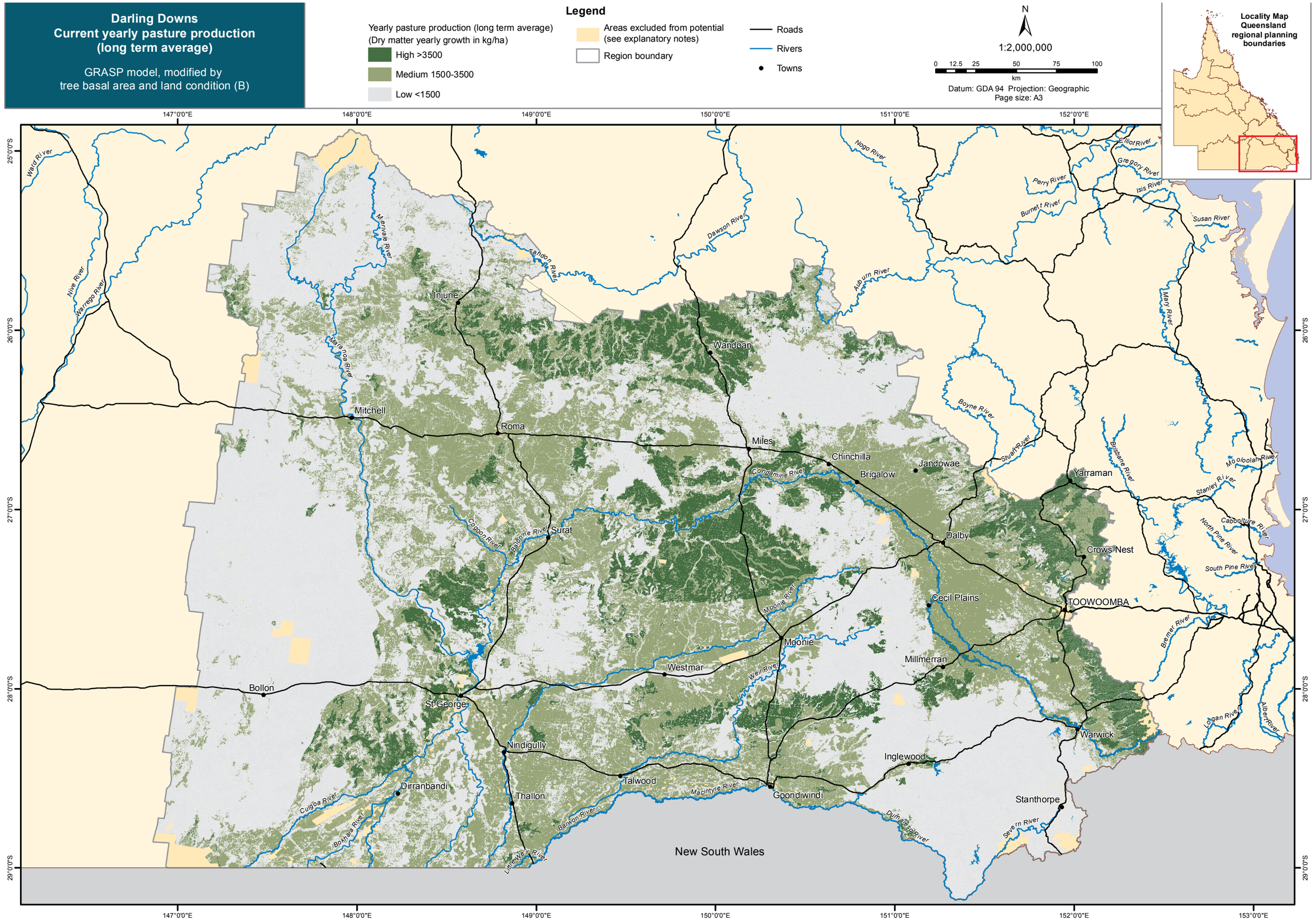
b) **excludes** production from land that is urban, intensive use (such as mining), national park, managed by the Department of Defence or permanently under water.

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.

Darling Downs
Current yearly pasture production (long term average)

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



Map 12.12 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.

Darling Downs
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

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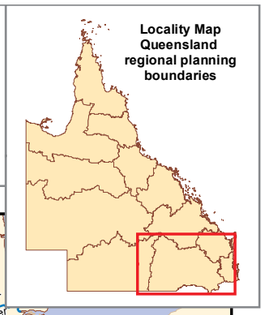
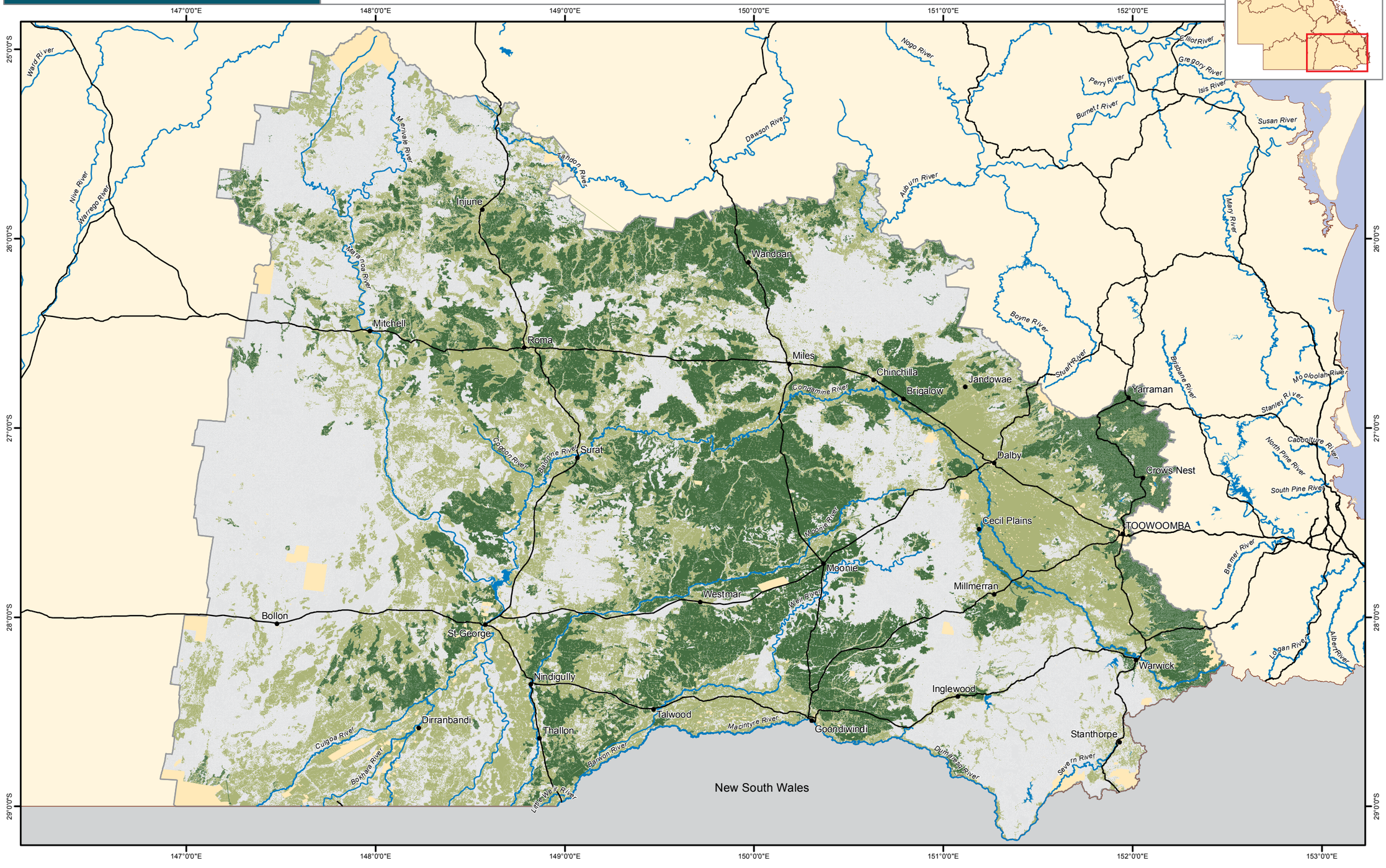
0 12.5 25 50 75 100
km

Datum: GDA 94 Projection: Geographic
Page size: A3





Map 12.13 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.

Darling Downs
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

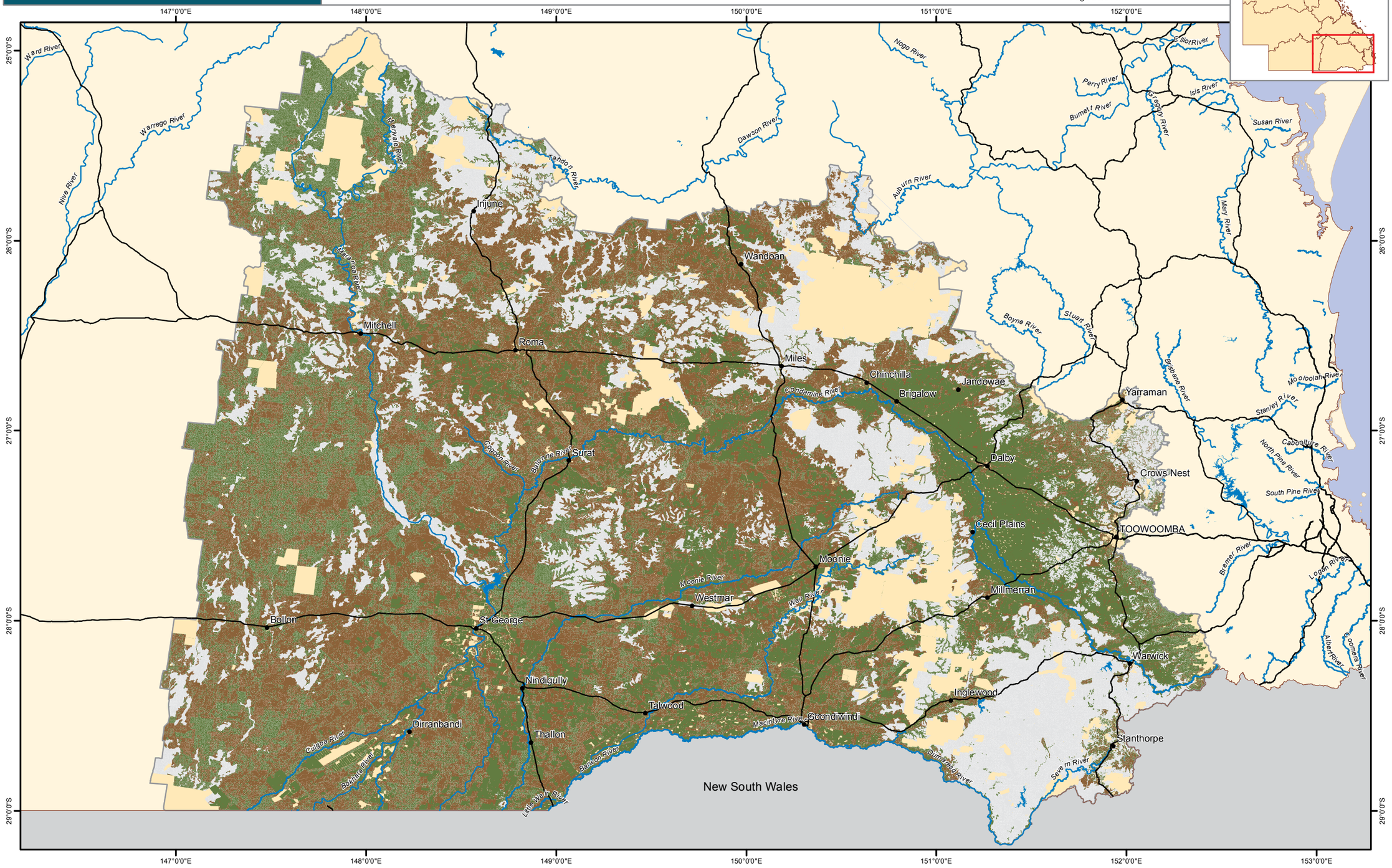
N

1:2,000,000

0 12.5 25 50 75 100 km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 12.14 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.

Darling Downs
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

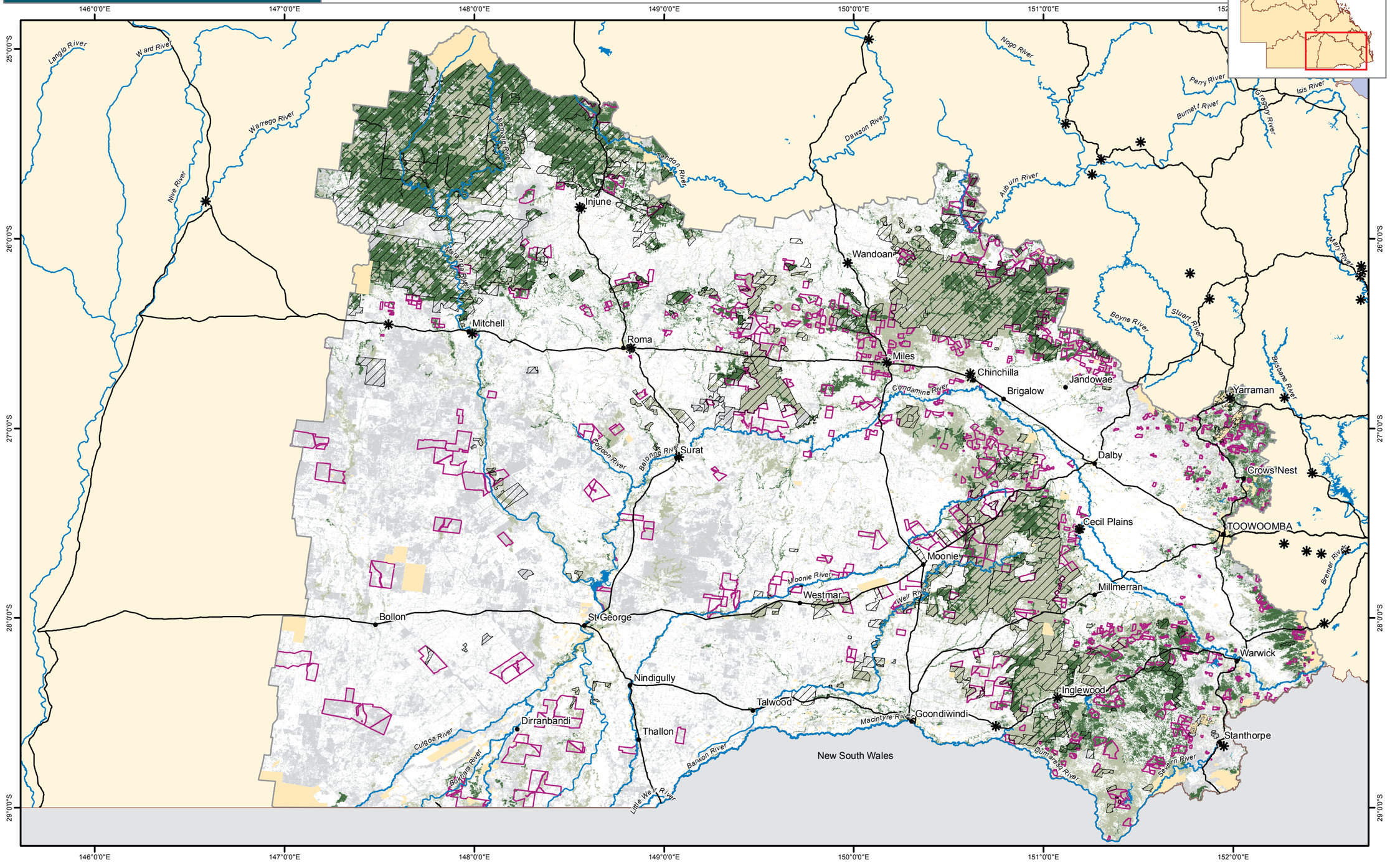
N

1:2,000,000

0 12.5 25 50 75 100 km

Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries



Map 12.15 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 12.2). See Section 12.1 for further constraints.

Darling Downs Biophysical potential for rainfed plantation forestry and current plantations

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' and 'C', slope <25%, rainfall >800mm 7 in 10 years, no cracking clays

Legend

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

N

1:950,000

0 5 10 20 30 40
km

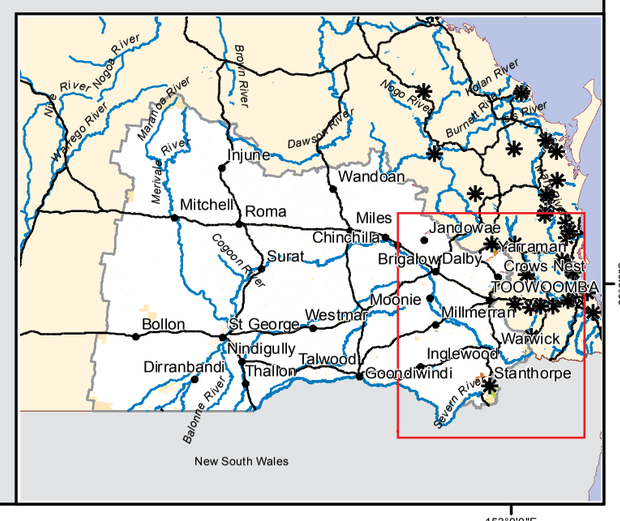
Datum: GDA 94 Projection: Geographic
Page size: A3

Locality Map
Queensland regional planning boundaries

151°0'0"E 152°0'0"E 153°0'0"E

27°0'0"S 28°0'0"S 29°0'0"S

Jandowae
Brigalow
Dalby
Moonie River
Cecil Plains
Weir River
Millmerran
Condamine River
Inglewood
Warwick
Stanthorpe
Dumaresq River
Severn River
New South Wales
Boyne River
Stuart River
Yarraman
Brisbane River
Mary River
Mooloolah River
Stanley River
North Pine River
South Pine River
Crows Nest
TOOWOOMBA
Bremer River
Logan River
Albert River



Map 12.16 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.

Darling Downs – Confidence in ALC data