SENATE REFERNCES COMMITTEE ON RURAL AFFAIRS & TRANSPORT

INDEX OF TABLED DOCUMENTS

Inquiry into the management of the Murray Darling Basin
Impacts of mining Coal Seam Gas

DALBY, QLD – TUESDAY, 19 JULY 2011

PART 2 of 2

Ms Anne Bridle	Copy of the Queensland Government Department of Natural Resources and Water, *Great Artesian Basin - resource operations plan 2007* Report. *(*See attached link) www.derm.qld.gov.au/wrp/pdf/gab/gab_rop.pdf	71
	Copy of the Queensland Government Department of Infrastructure, *Liquefied Natural Gas Whole of State Environmental Impacts Study,* 2007 Report. (See attached link) www.deedi.qld.gov.au/cg/resources/project/liquefied-natural-gas/matrix-lng-industry-report-full.pdf	37
	Copy of the Queensland Government Department of Natural Resources and Mines, *Hydrogeological Framework Report for the Great Artesian Basin Water Resource Plan Area*, 2005 Report. (See attached link) www.derm.qld.gov.au/wrp/pdf/gab/gab-hydrogeological-framework-report.pdf	155
	Copy of the Program Proposal, *Water, Agriculture and Mining: Regional Development Outcomes for Groundwater in the Condamine Alluvial and Surat Basin Aquifers* prepared for Regional Development Australia, by University of Southern Queensland;	20
	Condamine Alliance, *Environmental Values – Consultation Pack, February 2011*;	41
	Ground water concerns from Coal Seam Gas Extraction paper, Anne Bridle, 2010;	9
	A risk to Ground water from Coal Seam Gas Extraction in the Surat Basin, Bridle, A and Harris, C, 2010;	9
	Typical Queensland CSG Gas field and CSG Gas field Infrastructure photos;	4
	Copy of an article from *International Journal of Coal Geology 70 (2007), p.209-222,* "Coal petrology and coal seam contents of Walloon Subgroup – Surat Basin, Queensland, Australia", Scott, Anderson, Crosdale, Dingwall and Leblang. (See attached link) http://www.sciencedirect.com/science/article/pii/S016651620600111X	14
	Copy of the *Advice in relation to the Potential impacts of Coal Seam Gas Extraction in the Surat and Bowen Basins, Queensland* report prepared for the Department of the Environment, Water, Heritage and the Arts by Geoscience Australia and Dr M A Habermehl;	106
	Copy of Department of Sustainability, Environment, Water Population and Communities, Proposed Approval for Queensland Gas Company Ltd (QGC) And BG International Limited (BG) for coal seam gas field	41

	component of the Queensland Curtis LNG Project;	
	Letter from, QLD Government Department of Infrastructure and Planning to the Hon. Tony Burke MP, Minister for Sustainability, Environment, Water, Population and Communities, 18 October 2010, regarding Coal Seam Gas extraction near Gladstone.	4
	Copy of *Environmental Authority Applications* QGC areas map and information;	2
	Letter to Ms Bridle from QGC, 12 July 2011, regarding notice of application for internal review;	52
	Copy of the Oil & Gas Accountability Project (a project of Earthworks), *Our drinking water at risk* report. (See attached link) http://www.earthworksaction.org/pubs/DrinkingWaterAtRisk.pdf	76

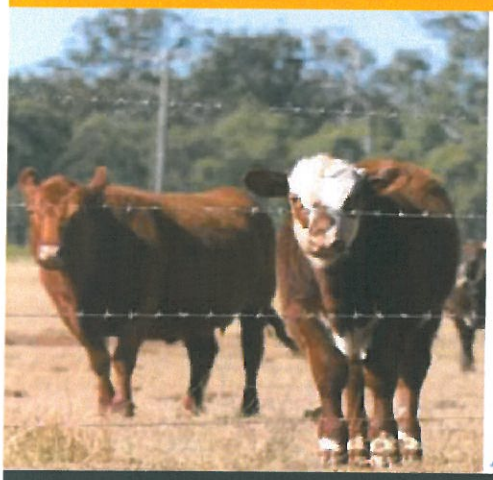
4

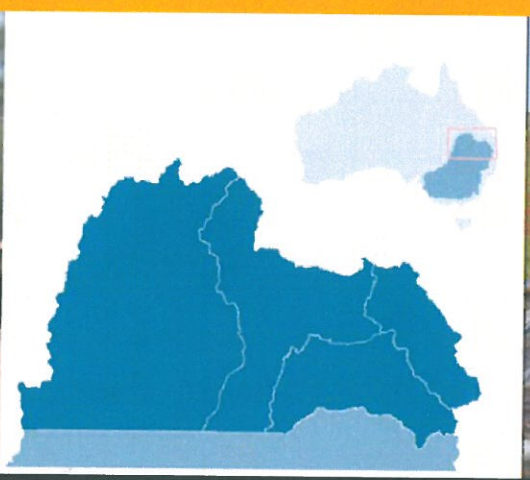
PROGRAM PROPOSAL USQ

Water, Agriculture and Mining:

Regional Development Outcomes for Groundwater in the Condamine Alluvial and Surat Basin Aquifers

Prepared for: Regional Development Australia





USQ Business Details

Name	University of Southern Queensland
ABN (Australian Business Number)	40 234 732 081
GST Registration	Yes
Incorporation	University of Southern Queensland Act 1998

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USQ Insurance Details

Public Liability	
Name of Insurer	QBE Insurance (Australia) Limited & ACE Insurance Limited
Policy Number	AT1023390PLB
Insurance Renewal Date	1 November 2010
Amount of Current Cover	$10,000,000 except Products Liability limited to $2,000,000 in USA/Canada
Professional Indemnity	
Name of Insurer	Zurich Industrial Insurance Limited
Policy Number	42 EP 00014 GPI
Insurance Renewal Date	1 November 2010
Amount of Current Cover	$20,000,000 each and every claim and in the aggregate
Situation	Worldwide, excluding North America
Workers Compensation	
Name of Insurer	WorkCover Queensland
Policy Number	WEA850693058
Insurance Renewal Date	30 June 2011
Amount of current cover	Total USQ Wages (confidential)

Contents

Introduction 4

Regional Background 5

Key Regional Groundwater Concerns 7

Research Knowledge Gaps and Current Activities 8

Key Regional Benefits 10

Regional Hydrogeology Program Outline 11

Program Research Focus Areas 11

Quantifying Connectivity Between the Condamine Alluvial and Shallow Underlying Aquifers 12

Inter-aquifer Leakage and Contamination Issues 13

Measuring Vertical and Lateral Transmission Rates and Aquifer Storage and Yield Parameters 14

Development of Appropriate Groundwater Monitoring Tools and Knowledge Management Interfaces 15

Resourcing 16

RDA Investment Opportunity 17

Program Linkages 18

Local Linkages 18

State Linkages 18

National Research linkages 18

Qualifications and Expertise 20

Publications Cited 20

INTRODUCTION

This document outlines the urgent need for, and benefits arising from, an RDA investment to improve the regional knowledge base regarding the groundwater resources of the Condamine Alluvium and shallow Great Artesian Basin aquifers throughout the Surat Basin. This program will deliver credible and independent regional hydrogeological knowledge which will enhance regional economic activity by underpinning community, industry and government investment decisions. In particular, the regional knowledge produced by this program will enable industry, community and government to:

1. Improve regional assessments of groundwater resources and hydrogeological processes;
2. Assess the impacts of coal seam gas (CSG) and coal mining operations on the water security, quality and availability for irrigated and urban communities on the Darling Downs and across the Surat Basin.
3. Improve the effectiveness of government policy and regulatory instruments related to minimising environmental and social impacts of coal seam gas and mining developments; and
4. Improve investment security for the regional communities and agricultural, CSG and mining industries.

The following figure provides a physical conceptualisation of the groundwater issues that will be addressed by this program. The conceptualisation will also serve to assist in understanding the program activities.

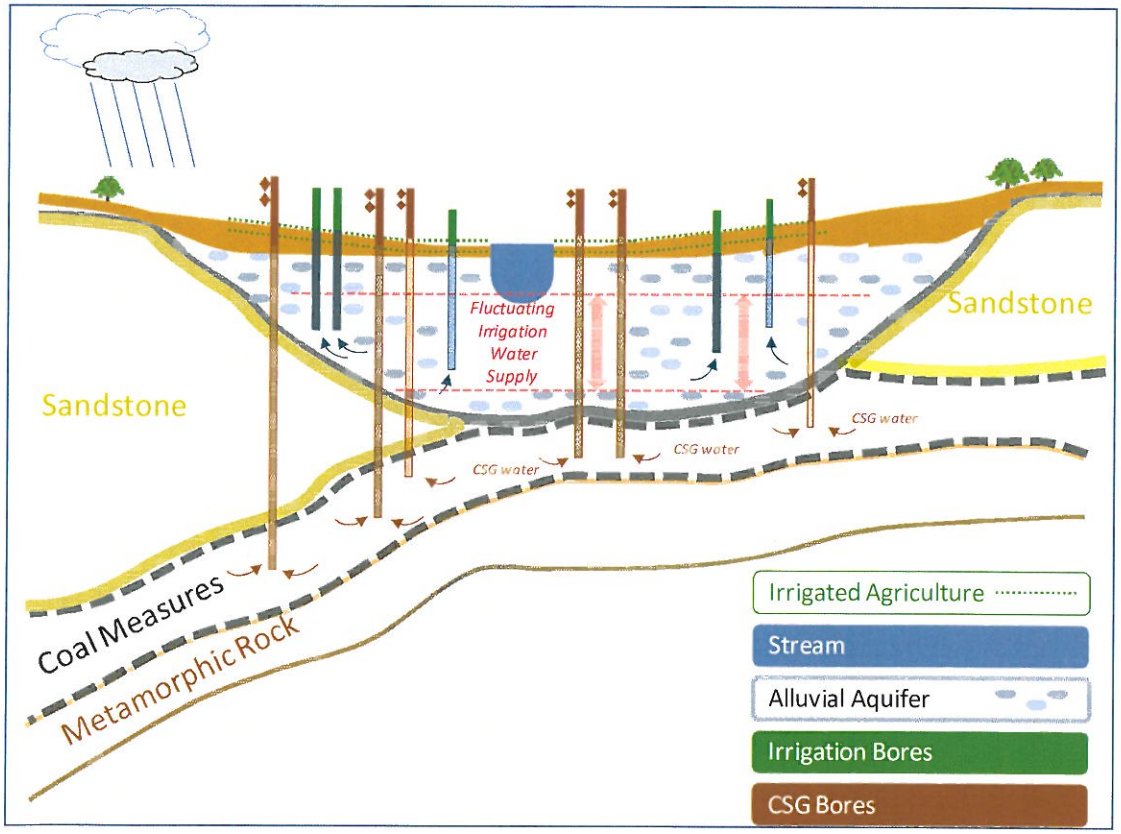

Figure 1 - Physical Conceptualisation of Groundwater Resources within the Condamine Alluvium and Coal Measures

REGIONAL BACKGROUND

The Darling Downs and Surat Basin are located within the Queensland Murray-Darling Basin (QMDB). The QMDB covers a geographical area of 260,791 km^2, making up 25% of the total Murray-Darling Basin (MDB). Agricultural and pastoral production currently accounts for the largest percentage of regional product output.

LOCAL COMMUNITITES AND THE IMPORTANCE OF A SECURE GROUNDWATER SUPPLY

Irrigators and rural towns in the Queensland Murray-Darling Basin region generally rely on a mix of both surface (i.e. river and overland flow) water and shallow alluvial groundwater. The majority of towns in the Western Downs and Surat region rely solely on groundwater for drinking supplies. Within the Western Downs Regional Council area, 18 out of 22 towns are dependant on underground water. Similarly, the grazing and feedlot industries rely on groundwater from the Great Artesian Basin (GAB) for animal drinking supplies while irrigation farms throughout the region often rely heavily on water from the shallow Condamine alluvial aquifer. Irrigated crop production occurs mainly on the deep fertile clay soils along the watercourses of the Darling Downs floodplains. This land is some of the most productive in Australia with the main crops being grain and cotton.

ECONOMIC VALUE OF REGIONAL PRIMARY INDUSTRIES

Water resources in Darling Downs and south-west Queensland region are primarily un-supplemented. Hence, the volume available for irrigation varies from 400-1000 GL/year depending on prevailing weather conditions and the region is heavily reliant on groundwater, especially during dry years. The total irrigated production from the region is worth approximately $1 Billion in an average year with a gross value of irrigated production ranging from $4028/ha to $6348/ha throughout the QMDB (Murray–Darling Basin Authority, 2010). The intensive animal feedlot industry on the Darling Downs is also worth between $197 and $271 Million per year. The QMDB also has significant environmental and ecological values with approximately 1000 key environmental assets (>40% of all environmental assets in the MDB) located in the region (Murray–Darling Basin Authority, 2010).

COAL SEAM GAS DEVELOPMENTS IN THE SURAT BASIN

The coal seam gas (CSG) industry in eastern Australia is experiencing a period of rapid expansion. A major focus of the current development is on the Surat Basin in south-west Queensland. The Surat Basin covers approximately 110000 km^2 and has an estimated 6 billion tonnes of thermal coal resources and more than 18,000 PJ of coal seam gas reserves (DEEDI, 2010). The capital investment in CSG infrastructure in the Surat region is expected to be more than $20 Billion.

Coal seam gas is recovered by drilling extraction wells into target coal seams. Groundwater is then pumped from the wells to lower the water pressure in the coal seam so that the gas (primarily methane) is released. CSG production is therefore dependent on groundwater extraction to facilitate recovery of the gas from the coal seams.

The Surat Basin CSG industry produces gas from the Walloon Coal Measures (WCM) which are a part of the Great Artesian Basin. The Walloon Coal Measures are directly overlain and underlain by low permeability geological units known as aquitards (or confining layers). These aquitards restrict

vertical groundwater flow between the coal measures and sandstone aquifers which are located both higher and lower in the geological sequence. Despite the low permeability of the aquitards overlying and underlying the Walloon Coal Measures, groundwater extraction to reduce the water pressure in the coal seams may induce some vertical leakage into the coal seams and produce impacts on the surrounding sandstone aquifers.

The CSG industry is planning to install up to 40,000 wells within the Surat Basin and extract up to 350,000 ML of groundwater per year.

Key points directly affecting the security of groundwater resource supplies within the Darling Downs and Surat Basin region include:

- Water drawdown within CSG aquifers is unavoidable (needed to liberate gas);
- Magnitude of drawdown is site specific - intensity of production, well-field configuration, aquifer hydraulic properties and geological conditions;
- Affects connected aquifers and spatially extends beyond initial depressurised zone;
- Aquifer recovery time is variable – dependent on connection, recharge rates, areal extent;
- The development and operation of CSG bores has the potential to contaminate groundwater systems and to adversely impact on existing landholders; and
- The extraction of water from the Walloon Coal Measures and shallower aquifers is expected to have wide spread and long (estimates from 100 to 1000 years) term impacts on groundwater availability.

COMPETING REGIONAL WATER DEMANDS

There are two main factors contributing to the current uncertainty regarding water security within the Darling Downs and Surat Basin region. These are:

1. Changes within the Murray-Darling Basin Plan to reduce water allocations and enhance environmental flows; and
2. Development and expansion of the CSG and mining industry and the impact of these operations on groundwater security.

Cut-backs to water allocations in the Condamine-Balonne catchment as proposed by the Murray-Darling Basin Authority (2010) include 203-272 GL/year to surface water and 45 GL/yr to groundwater extractions. The recent development of the CSG industry within the Darling Downs and south-west Queensland region has raised significant community and agricultural sector concerns regarding the impacts on existing on groundwater resources, long term sustainable diversion limits and the sustainability of the surrounding farmlands and landscapes. These concerns directly impact

on investment in irrigation infrastructure, regional urban water security and the development of water policy and local implementation of the Murray-Darling Basin plan.

KEY REGIONAL GROUNDWATER CONCERNS

There are significant challenges to ensuring sustainable water management within the Darling Downs and Surat Basin. The key areas of conflict between the regional and agricultural communities and the CSG industry involve the impact of CSG operations on both shallow alluvial and GAB groundwater resources, contamination of aquifers through CSG operations and the environmental impact of discharging and/or utilising the water produced by CSG operations into the landscape. A significant limitation in developing effective strategies to manage these conflicts is the lack of adequate underlying knowledge about the groundwater systems in the region.

Specific questions being asked by the community in relation to CSG and mining operations and areas that require further research and investigation include:

- What are the sustainable recharge rates, storage and yield of alluvial and GAB aquifers in the region? How is this affected by climatic conditions?
- What is the connection between overland flows, river water and shallow aquifers?
- What is the extent of connection between the alluvial aquifers and the aquifers associated with CSG production?
- What is effect of water extraction and aquifer depressurisation due to CSG operations on groundwater supplies? Over what timeframe and how long to recover?
- What will be the localised and cumulative groundwater impacts associated with CSG drilling and water extraction?
- What is the potential for inter-aquifer leakage and impacts on local and regional water allocations and water quality?
- What contamination of aquifers is occurring from CSG operations either through direct chemical releases or via inter-aquifer transfers of saline water?
- How much water is going to be produced by CSG operations? What is the water quality of the water and how does this vary across the region and over time?
- What is the potential to utilise the water extracted by CSG operations to either offset or increase water allocations for rural or town use?
- Can the treated CSG water be used to replenish shallow groundwater aquifers? How will this be managed?
- If treated CSG water is used for irrigation in saline upland areas, what is the potential for mobilisation of salts in the landscape into rivers or groundwater systems? How will this be monitored and managed?

RESEARCH KNOWLEDGE GAPS AND CURRENT ACTIVITIES

Significant geological, soils, landscape and agricultural differences across the CSG and mining development areas mean that each of these questions can only effectively be resolved by understanding the whole landscape water balance at a local scale. Compounding the difficulty in answering these complex and pressing questions are gaps in the existing knowledge base specifically relating to:

- Lack of adequate data on the water quality and interconnectivity of groundwater systems at a local scale,
- Identification and assessment of local geological features and discontinuities,
- Lack of vertical and horizontal permeability measurements in key strata,
- The sustainable recharge and extraction rates of aquifers, and
- A lack of local, independent groundwater expertise to assist in the objective evaluation of the impacts associated with planned developments.

There is a complex combination of geological, agricultural, social and environmental issues associated with managing CSG and mining industry impacts on groundwater in the Condamine Alluvial Aquifer and more broadly within the Surat Basin.

Existing knowledge and the local human and research capacity to support regional developments dependent on these groundwater resources is largely fragmented and incomplete.

PREVIOUS AND CURRENT CSG AND GROUNDWATER RELATED ACTIVITIES

The Queensland Department of Environment and Resource Management (DERM) is currently conducting the "Healthy Headwaters (HH) Coal Seam Gas Water Feasibility Study" on behalf of the Commonwealth Department of Sustainability, Environment, Water, Population and Communities. This project is principally using consultants to collate the existing knowledge in relation to regional CSG issues and to identify knowledge gaps and research needs. This project was started in February 2009 and will end on the 30th June 2012. The HH project is currently collating information in relation to the Walloons hydrogeology, CSG water production and re-injection options for treated CSG water. USQ staff have been involved in several activities within this project as well as other Healthy Headwaters programs. USQ will continue to build on the outputs of the Healthy Headwaters activities in addressing research knowledge gaps.

The Queensland Water Commission (QWC) has been tasked with assessing CSG water impacts in cumulative management areas. Its role includes groundwater impact monitoring, groundwater modelling, and preparation of cumulative impact reports. The QWC is currently in the process of developing a groundwater model to enable the prediction of cumulative impacts in the Surat Basin. The QWC is also expanding its current capability in relation to groundwater monitoring and assessment but does not have a research capability. USQ is expecting to work closely with QWC to

deliver research knowledge outcomes to enhance the QWC monitoring, modelling and reporting outputs and capability.

USQ'S EXISTING IRRIGATED FARMING AND LANDSCAPE RESEARCH

As the local university, USQ is already a leading provider of research addressing rural and regional issues affecting southern Queensland. Relevant areas of existing research capability include:

- *engineering in agriculture and rural environments to improve the profitability, environmental sustainability and socio-economic wellbeing of our rural industries, their natural resource base, and the manufacturing and service sectors which support them;*
- *the sustainable management of natural resources and connections with communities within our catchments; and*
- *spatial modelling tools to support the development of sustainable land and water management.*

In particular, USQ has existing research strengths in irrigated farming and water supply systems within the National Centre for Engineering in Agriculture (NCEA) and water resource engineering within the Australian Centre for Sustainable Catchments (ACSC). The NCEA provides leadership in research, training and commercialisation in the fields of irrigation and natural resource management, and agricultural and bio-systems engineering. The ACSC combines world leading research and development in climate and meteorological science with engineering, remote sensing and surveying, hydrological modelling, economic modelling, catchment-scale modelling and rural research. These centres conducted more than $3.5 M worth of externally funded research during 2010.

USQ recently completed a preliminary assessment of cumulative groundwater draw down impacts due to CSG operations (USQ, 2011). The study was conducted on behalf of four major CSG companies and compared the latest company groundwater models.

The study found the companies the conceptual geological models used by each company varied and that there were significant differences in the hydraulic conductivity (see box below), specific storage and specific yield parameters adopted by each company. In some cases the parameters varied by several orders of magnitude. No company accounted for potential connections with overlying alluvial aquifers.

The NCEA has conducted research to support irrigated farming communities throughout the Murray-Darling Basin for more than 18 years. The NCEA was a core partner in the CRC for Irrigation Futures and has a close working relationship with irrigators that are dependent on the Condamine Alluvial Aquifer. However, the NCEA has also been conducting research funded by the CSG companies into the use of treated CSG water for irrigation throughout the Darling Downs for more than four years. This places the USQ and particularly, the NCEA, in the unique position of having existing research linkages with the main stakeholders involved in groundwater use within the Darling

Table 3.2: Horizontal Hydraulic Conductivity Values (Kh)

Unit	Aquifer/ Confining Unit	Horizontal Hydraulic Conductivity Kh (m/d)				
		CSG 1	CSG 2	CSG 3	CSG 4	Proposed
Cainozoic & Alluvium	A	0.22-5.0	0.036/0.0036	0.31	5.0	Variable
Rolling Downs Group	C	0.05		0.027	0.001	0.01-0.05
Bungil	A	0.12	0.036/0.0036	0.022	0.001	0.1-0.5
Mooga	A		0.036/0.0036	0.117	0.5	
Orallo	C		0.0036/ 0.00036	0.25	0.1	0.1-0.5
Gubberamunda	A	0.31	0.36/0.036	0.49	0.5	0.3-0.5
Westbourne	C	0.0056	0.001/0.0001	0.0026	0.001	0.001-0.005
Springbok - upper	A	0.28	1.25	0.12	0.5	0.3-1.0
Springbok - lower	C					0.001-0.005
Walloon Upper	C	0.00044	0.0025/ 0.00025	0.0015	0.05	0.0005-0.005
Walloon Coal Seam (Macalister)	A	0.0025	1.36/0.014	0.004	0.001	0.001-0.005
Walloon (Macalister Mudstone)	A	0.00015	0.005/ 0.0005	0.0015		
Walloon (U Juandah Sst)	A	0 14				
Walloon (L Juandah Mudstone)	C	0.00015				
Walloon (L Juandah Coal seam)	A	0.0064		0.004	0.001	
Walloon (L Juandah Mudstone)	C	0.00015		0.0015	0.001	
Walloon (Tangalooma Sandstone)	A	0.14			0.05	
Walloon (Taroom Mudstone)	C	0.00015			0.001	
Walloon (Taroom Coal Seam)	A	0.0074	1.36/0.014	0.004	0.001	
Walloon (Taroom Mudstone)	C	0.00015	0.0025/ 0.00025	0.0011	0.001	0.001-0.005
Eurombah Fm	C	0.00062		0.0011	0.05	
Upper Hutton Sandstone	A	2.4	0.1/0.01	0.13	0.1	0.1-0.5
Lower Hutton Sandstone	A	0.12				
Evergreen	C	0.00065	0.01/ 0.0001	0.003	0.001	0.0005-0.001
Precipice	A	3.1	3.8/0.38	0.21	1.0	1-4
Moolayember Fm	C	0.0025	-	-	-	-

Source: University of Southern Queensland, 2011

Downs and Surat Basin region. Both the NCEA and ACSC also have strong linkages with international agencies involved in irrigation and water resource management.

KEY REGIONAL BENEFITS

Key benefits that will be experienced by regional communities in the Darling Downs and Surat Basin due to the increase in regional groundwater knowledge produced this program include:

- Investment security for irrigation farming communities;
- Secure and safe drinking supplies for rural townships;
- Viable job creation and security in the agricultural and CSG industries;
- Improved capacity to quantify groundwater resources;
- Known impacts of CSG developments on groundwater;
- Improved environmental flow and water quality outcomes;
- Knowledge base for policy development; and
- Better informed communities through publication of transparent and credible data.

REGIONAL HYDROGEOLOGY PROGRAM OUTLINE

This Regional Hydrogeology Program will directly address the many challenges and concerns faced by the towns and irrigated farming communities of the Darling Downs and south-west Queensland region. While this program will focus on the key research gaps and questions posed by towns and irrigated communities associated with the Condamine Alluvial Aquifer, the learnings, frameworks and tools developed by this program will be applicable to other agricultural catchments faced with CSG and mining developments throughout eastern Australia.

The overarching aim of this program is to:

> *Provide independent and credible field evaluation and monitoring data to enable assessment of aquifer characteristics and the impacts of agricultural, CSG and mining operations on the security of the regional groundwater resources.*

PROGRAM RESEARCH FOCUS AREAS

Figure 2 below identifies the four main Research Focus Areas where field studies and research activities will be conducted. Details on each of these program areas are outlined in the text following.

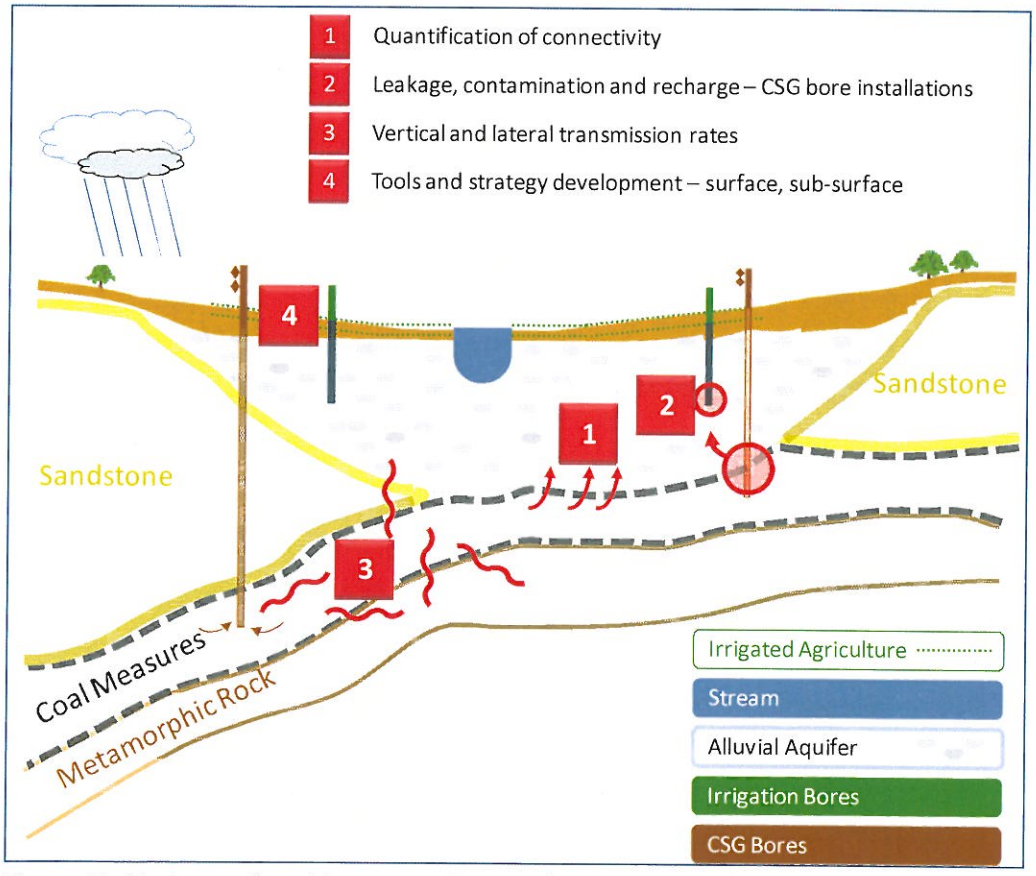

Figure 2 - Hydrogeology Program - Research Focus Areas

1 QUANTIFYING CONNECTIVITY BETWEEN THE CONDAMINE ALLUVIAL AND SHALLOW UNDERLYING AQUIFERS

This activity will collect field data and conduct local shallow groundwater modelling to quantify the extent of connectivity between the Condamine Alluvial Aquifer and the Walloon Coal Measures.

The alluvium of the Condamine River has been deposited in a broad valley, and consists of unconsolidated clay, silt, sand and gravel. The alluvium is incised into the Walloon Coal Measures which is complex, with non-continuous beds, thickening and thinning of layers (shales, sandstone and coal) and varying hydraulic connections between layers. There is currently little measured data available on the hydraulic connections between the Condamine Alluvial Aquifer and the underlying coal seams.

This activity will build on Activity 1.1 of the Healthy Headwaters Coal Seam Gas Water Feasibility Study which is conducting a "desktop" study to collate existing data but which will not collect any new field data. However, because of the very real likelihood of groundwater movement from the alluvium to the coal measures, more data is required to allow the development of a numerical model and evaluation of the risks associated with depressurisation of the Walloon Coal measures.

This research activity will obtain field data to develop a more detailed understanding of the water balance components within the Condamine alluvial and underlying aquifers. use geophysical surveys, groundwater chemistry, tracer studies and analyse bore and groundwater data to measure the hydraulic conductivity of the various strata within the alluvium and the underlying geological layers. Depressurisation and groundwater extraction from the Walloon Coal Measures will be measured. This work will also build on previous research conducted at USQ measuring recharge rates into the overlying alluvial aquifer due to rainfall, stream flow and irrigation management. This data will be used to develop and calibrate an improved integrated shallow groundwater model of the Condamine Alluvial and the underlying aquifers. This model will be used to evaluate the impacts of depressurising the Walloon Coal Measures under a range of scenarios and to improve confidence in the evaluation of sustainable water extraction limits for the alluvial groundwater system.

Key Outcomes

- Improved regional knowledge base regarding the volume and security of groundwater resources within the Condamine Alluvial Aquifer and connected aquifers.
- Increased investment confidence around agricultural and CSG operations within the Surat Basin in general and specifically, the Central and Western Downs region.

2 INTER-AQUIFER LEAKAGE AND CONTAMINATION ISSUES

This activity will conduct research to improve the knowledge base regarding inter-aquifer leakage and contamination issues associated with CSG bore installation and operation and other mining activities.

Recent media attention has highlighted the potential for contamination of aquifers through the installation and operation of CSG bores either via introduced chemicals or by leakage between aquifers due to bore construction and operation. There is potential for aquifer contamination due to coal mining activity activities throughout the Darling Downs region. However, there is currently inadequate local knowledge and human capacity available to understand contamination risks and to develop effective management strategies.

This research activity will evaluate the incidence of inter-aquifer bore leakage and the impact of bore design, installation and management practices on leakage and contamination as well as the incidence and potential for contamination from mining activities. Chemical tracers, CSG water geochemical signatures, contaminant chemicals and modelling will be used to evaluate the incidence of contamination and to measure chemical diffusion and degradation rates under a range of aquifer conditions. This study will also evaluate options for the management of leakage and contaminated aquifers to minimise environmental impacts. Laboratory and field studies will be undertaken to evaluate the potential to remediate contaminants using chemical, physical or biological means.

This research data will also have relevance in assessing strategies for reinjecting treated CSG water into aquifers. Depending on the outcomes of current work by the Healthy Headwater program (Activity 6 Risks and feasibility of injecting CSG water and brines into aquifers) there is the potential for this activity to conduct a field evaluation of options including a pilot reinjection study.

Key Outcomes

- Improved knowledge and community understanding regarding the potential for groundwater contamination and impacts of groundwater contamination from CSG operations.
- More effective policy and implementation practice derived from improved knowledge regarding remediation actions for contaminated aquifers.

3 MEASURING VERTICAL AND LATERAL TRANSMISSION RATES AND AQUIFER STORAGE AND YIELD PARAMETERS

This activity will measure vertical and lateral transmission rates and aquifer storage and yield parameters within GAB aquifers and aquitards above the Walloon Coal Measures

A major limitation to the modelling and evaluation of existing groundwater resources and the impacts of CSG operations on water security is the lack of existing data on vertical and lateral transmission rates within the key aquifers and aquitards in the region. The research conducted in this program activity will involve regolith studies including the evaluation of transmission rates, specific storage and specific yields of both aquifers and aquitards affected by the coal seam gas operations. This work is expected to extend beyond the immediate geological formations underlying the Condamine Alluvial Aquifer to also measure aquifer and aquitard characteristics of key GAB hydrogeological formations affected by CSG and mining operations within the Darling Downs region.

Vertical and horizontal transmission rates of aquitards will be evaluated using both small core and infield measurements of bore drawdown and extraction rates. Specific storage parameters will be measured using geotechnical rock strength and stress properties measured in extracted cores. For aquifers where dewatering is expected to occur (as opposed to just depressurisation), hydraulic testing supported by laboratory testing will be used to determine specific yield parameters.

Cores of up to 100 mm in diameter will be extracted from both aquitard and aquifer layers for moisture retention and hydraulic conductivity measurements. Pore extraction will be conducted on small cores (up to 75 mm diameter) locally using a benchtop centrifuge and larger cores (up to 100 mm diameter) will be evaluated in partnership with the NCGRT geotechnical centrifuge permeability facility located at the UNSW. Field measurements and hydraulic testing of bores in both the Condamine Alluvial Aquifer and the GAB aquifers used for agriculture will be conducted to examine spatial heterogeneity and preferential flow at a larger scale.

Key Outcomes

- Improved regional knowledge base regarding aquifer and aquitard properties and the prediction of impacts associated with CSG operations on both the GAB and shallow alluvial aquifers.
- Improved policy formulation and more secure environment for investment in agriculture and CSG operations

4 DEVELOPMENT OF APPROPRIATE GROUNDWATER MONITORING TOOLS AND KNOWLEDGE MANAGEMENT INTERFACES

This activity will focus on the development of (a) cost-effective monitoring tools and strategies for closing the water balance and assessing groundwater impacts and (b) interfaces to improve stakeholder engagement with groundwater data and knowledge.

A key limitation in the management of groundwater systems is the ability to rapidly measure and monitor extractions and impacts at an appropriate time and spatial scale. This information also needs to be presented in readily available in real time for access by all stakeholders (i.e. government, community and industry). This activity will focus on (a) the development of cost effective sensing and instrumentation strategies for assessing hydrogeological characteristics and groundwater responses, and (b) the development of a information portal visualisation and interfacing tools to enhance stakeholder access and engagement with water resource data. This activity does not intend to create or maintain a groundwater information portal but rather to enhance the effectiveness and utility of groundwater data collected and maintained by Government agencies. In particular, it is expected that this activity will work closely with the QWC, community groups, and where appropriate CSG companies, to ensure that interfaces are appropriate to the available data and stakeholder requirements.

This work will build on USQ's success in developing low-cost, telemetry based sensors for the water industry and web-based data storage and performance evaluation interfaces for the irrigation sector. It will also investigate novel mathematical processes to evaluate options to better target the location, and reduce the number of, real-time field sensors required to characterise groundwater responses. GIS and spatial modelling technologies will be used to provide web-enabled real-time 3D representations of regional geology, water extraction and groundwater impacts.

Key Outcomes

- Improved transparency and immediacy of regional data regarding groundwater responses and impacts associated with recharge and extraction events.
- Better informed community, industry and Government engaging on more effectively to resolve resource conflicts.

RESOURCING

This program will involve USQ staff from the Faculty of Engineering and Surveying, Faculty of Sciences and the National Centre for Engineering in Agriculture. The core program team will be led jointly by:

- Professor Steven Raine who has expertise in irrigation and soil physics and worked extensively with both the irrigated community and coal seam gas companies in the Queensland Murray-Darling Basin, and a
- New Professorial level appointment in hydrogeology with expertise in the quantification of groundwater resources and contaminant flows.

Other key team members include:

- A/Prof Yury Stepanyants and A/Prof Dmitry Strunin who are experts in fluid dynamics, transport phenomena in continuous media including porous media (this includes heat and mass transport, diffusion, advection and wave transport), thermoelasticity, nonlinear physics, mathematical modelling, computational methods and applied mathematics.
- A/Prof John Worden who is a geologist with over 30 years experience investigating the geological sequences and conducting geochemical and geochronological research.

This program will also involve an additional three full-time research and professional staff with hydrogeological expertise and a further five PhD research students. These new staff and students will provide a key capacity within the region to deal with groundwater resources issues beyond the project period.

Program funds are required for both laboratory and field equipment associated with this program and for field and laboratory consumable expenses. In particular, there will be a need to access bore hole drilling rigs and for the purchase of hydrogeological field sensing and laboratory analysis equipment.

RDA INVESTMENT OPPORTUNITY

This program will enhance regional economic development and the implementation of national water planning processes within the Queensland Murray-Darling Basin through an investment of $5.5 million over a period of 5 years. Outlined below is the budget sought from Regional Development Australia for this program.

	Year 1	Year 2	Year 3	Year 4	Year 5
Salaries					
Research staff (inc. on-costs)	$ 610,000	$ 640,500	$ 672,525	$ 706,151	$ 741,459
Technical support (inc. on-costs)	$ 60,000	$ 63,000	$ 66,150	$ 69,458	$ 72,930
Postgraduate stipends	$ 60,000	$ 120,000	$ 150,000	$ 90,000	$ 30,000
Operating					
Bore drilling	$ 120,000	$ 130,000	$ 140,000	$ 120,000	$ 80,000
Travel and field consumables	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 45,000
Chemical analyses	$ 20,000	$ 35,000	$ 40,000	$ 45,000	$ 50,000
Laboratory consumables	$ 20,000	$ 22,000	$ 28,000	$ 30,000	$ 35,000
Capital					
Laboratory equipment	$ 110,000	$ 110,000	$ 40,000	$ 10,000	$ 10,000
Bore hole sensing and telemetry	$ 80,000	$ 110,000	$ 80,000	$ 80,000	$ 30,000
Total	**$ 1,110,000**	**$ 1,260,500**	**$ 1,246,675**	**$ 1,180,609**	**$ 1,094,389**

Table 1 - Program Costing

PROGRAM LINKAGES

Strong linkages already exist between staff involved in this program and community, industry and Government agencies dealing with water, agriculture and mining within the Queensland Murray-Darling Basin. This program will continue to actively develop appropriate linkages at the Local, State and Federal level as outlined below.

LOCAL LINKAGES

The program team will work closely with existing research groups within the University of Southern Queensland with strengths in irrigated farming and water supply systems, water resource engineering and regional and economic development. There will also be close linkages with local agricultural, CSG industry and community operatives. These linkages are already evident through the local irrigation community pledging $100,000 over three years to provide a postgraduate student stipend.

STATE LINKAGES

This program will build on the current "Healthy Headwaters (HH) Coal Seam Gas Water Feasibility Study" being conducted by Qld DERM on behalf of the Commonwealth Department of Sustainability, Environment, Water, Population and Communities. It will also address an existing institutional research gap by complementing and supporting the:

1. Regional monitoring, modelling and assessment capability within the Queensland Water Commission;
2. Emerging developing operational capability within the DERM CSG group; and
3. Existing community and irrigated agriculture engagement capability within DEEDI.

In particular, the program will also work closely with the Queensland Water Commission and Department of Environment and Resource Management to ensure that the data, knowledge and outcomes produced are aligned with State Government initiatives including the development of the regional cumulative impacts groundwater model and an effective groundwater monitoring and regulatory enforcement program.

NATIONAL RESEARCH LINKAGES

Research activities undertaken in this program will integrate with the National Centre for Groundwater Research and Training (NCGRT) program areas:

- *Innovative Characterisation of Aquifers and Aquitards,*
- *Hydrodynamics and Modelling of Complex Groundwater Systems,*
- *Surface Water - Groundwater Interactions, and*
- *Integrating Socioeconomics, Policy and Decision Support.*

The NCGRT has indicated that it will provide funding to support research collaboration with other partners within the NCGRT. It is expected that this funding would total approximately $100,000 per year and would be in addition to funds requested from RDA.

The program will be closely linked with the Integrated Catchment Assessment and Management Centre (iCAMS) within the Fenner School of Environment and Society at the Australian National University. The USQ and ANU have a formal alliance providing for collaborative research, research staff exchanges and summer student research scholarships. This alliance will provide an effective platform for the development of close working relationships particularly in the area of quantifying social and economic trade-offs in relation to groundwater management options.

Preliminary discussions with CSIRO have already been held with a view to formalising research linkages with relevant CSIRO expertise at a national level, particularly in relation to the characterisation of the GAB aquifer characteristics and the identification of sustainable diversion limits within the northern Murray-Darling Basin.

QUALIFICATIONS AND EXPERTISE

The University of Southern Queensland (USQ) is based in Toowoomba, Queensland. USQ has a substantial presence outside of Toowoomba with a campus in Hervey Bay (Fraser Coast) a more recently established campus at Springfield in Brisbane. As the local university, USQ is already a leading provider of research addressing rural and regional issues affecting southern Queensland.

Relevant areas of existing research capability include:

- *Engineering in agriculture and rural environments to improve the profitability, environmental sustainability and socio-economic wellbeing of our rural industries, their natural resource base, and the manufacturing and service sectors which support them;*

- *The sustainable management of natural resources and connections with communities within our catchments; and*

- *Spatial modelling tools to support the development of sustainable land and water management.*

USQ's world class research into irrigated farming and water supply systems has involved meant high level involvement from different industry and government bodies including Central Downs Irrigators Limited, Western Downs Regional Council, Santos Limited, Arrow Energy Limited and the British Gas Group.

PUBLICATIONS CITED

DEEDI 2010, Queensland Coal Seam Gas Overview. Department of Employment, Economic Development and Innovation. April, 2010. Brisbane.

Murray–Darling Basin Authority 2010, Guide to the Proposed Basin Plan: Overview, Murray–Darling Basin Authority, Canberra.

University of Southern Queensland 2011, Preliminary Assessment of Cumulative Drawdown Impacts in the Surat Basin Associated with the Coal Seam Gas Industry. University of Southern Queensland, Toowoomba.

Environmental Values

Consultation Pack

February 2011

Condamine Alliance

PEOPLE WATER LAND WILDLIFE

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Introduction

There is currently no way for the Condamine catchment community to provide developers, planners and other decision-makers with information that will help protect the water of the catchment for the uses that the catchment community values. The process to develop this information is through the setting of local water quality guidelines as outlined in the Environmental Protection (Water) Policy 1997 and subsequent policy in 2009 and in the Queensland Water Quality Guidelines (DERM, 2009).

Condamine Alliance and a range of catchment stakeholders have begun to address this lack of information for planners and developers by commencing the process that leads to the development of local water quality guidelines and objectives. Still in the early stages of the process, the Condamine Alliance is developing the water values (called environmental values, but encompassing twelve different values from industrial use, to recreation, to cultural and spiritual values) upon which to base water quality protection parameters.

It is important to note that this process is about what the community (rather than individuals) values the water for (now and in the future), and not what the water is currently used for, and doesn't involve any discussion on the quantities of water or water allocations. This process is about preservation of water quality and waterway health to meet community values over time rather than deciding what or who can use the water. It is recognised that water quality and water quantity are intimately interrelated, but separate mechanisms currently manage these aspects and only water quality can be addressed through the current environmental values mechanism.

What are Environmental Values?

Draft environmental (water) values have been developed for the catchment through input from a range of stakeholders including regional councils, state government agencies, industry bodies, the Murray-Darling Basin Authority and local community groups. These values will provide the basis upon which water quality protection parameters will be set to assist developers, planners and other decision-makers.

To record the values in the most useful way for undertaking the remaining steps in the process and to achieve a useful end product, the values have been assigned to small sections of the catchment to illustrate the differences and identify the coinciding values. Coinciding values should not be considered to be in conflict, as protection of a high water quality value such as a drinking water supply, is likely to also ensure that the water is suitable for irrigation. This does not imply that one or other value takes precedence.

The environmental (water) values being addressed are those listed in the Queensland Water Quality Guidelines (DERM, 2009), including:

- Aquaculture
- Aquatic ecosystems (incorporating Habitat value)
- Cultural and spiritual values
- Drinking water (raw water supplies taken for drinking)
- Farm supply (e.g. fruit washing, milking sheds, intensive livestock yards)
- Human consumption (e.g. of wild or stocked fish)
- Industrial use (e.g. power generation, manufacturing, road maintenance)
- Irrigation

- Primary recreation (fully immersed in water e.g. swimming)
- Secondary recreation (possibly splashed with water, e.g. sailing)
- Stock watering (e.g. grazing cattle)
- Visual appreciation (no contact with water, e.g. picnics)

How are they used?

Environmental values and water quality objectives have been set for many of Queensland's coastal waterways including Moreton Bay/south-east Queensland, the Mary River Basin/Great Sandy Region, Douglas waters and Trinity inlet. The environmental values and water quality objectives for these areas are documented in Schedule 1 of the Environmental Protection Policy (Water) and in the Queensland Water Quality Guidelines (DERM, 2009).

Environmental values and water quality objectives are developed to provide locally relevant guidelines as benchmarks for the assessment and protection of local water quality. This provides the framework under which a Healthy Waters Management Plan can be developed to assist the community achieve its water objectives over time, and under which the development approvals process is empowered to ensure that new developments protect the environmental values and water quality objectives set by the community.

How have they been assigned so far?

There have been several steps involved in developing the draft environmental values so far. These include the segmentation of the catchment's waterways (surface and groundwater), the assignment of values by calculation against criteria, and community feedback and adjustment of the values.

Segmentation of the catchment

The local area covered by this work is the Condamine catchment, which includes the Condamine River and its tributaries from the Great Dividing Range near Killarney and Dalveen through the Dalby plain to approximately 20 kms west of Chinchilla (See Map 1). It also includes the groundwater stored in aquifers across this same area.

Previous division of the catchment into subcatchments for work undertaken through the State of the Rivers project, and carried through the Environmental Protection Agency's (now Department of Environment and Resource Management) Aquatic Conservation Assessment process were adopted for ease of continuity as they provided sufficient detail to allow differentiation of values across the variability of the physical catchment.

Groundwater aquifers were identified from geological information by the Department of Environment and Resource Management with only some aquifers subdivided into smaller 'subcatchment-style' areas based on natural edges of the aquifer or changes in groundwater chemistry (e.g. salinity).

Assignment of values

The values assigned to water in each subcatchment (or aquifer area) were recorded as being attached to the source of the water rather than its point of use. This allows for water in a dam to be valued for a use such as drinking water or irrigation, rather than

applying the drinking water value at the town or the irrigation value at the receiving paddock.

It should be noted that values were recorded as applicable only in the subcatchment (or aquifer area) to which they directly applied and not expanded into neighbouring subcatchments (or aquifer areas) simply due to flow or proximity. This allows for very specifically addressing the values in each location, and requires development and management decisions made on upstream areas to consider the impact on downstream values to ensure their protection as well as protection of the values applicable in the subcatchment of direct interest. For example, a subcatchment containing a drinking water source was identified as having drinking water value. Subcatchments upstream of that drinking water source may not contain drinking water value of themselves. When planning and undertaking activities in the upstream subcatchments, decision-makers should consider the potential impacts on downstream values and manage them accordingly.

Who has been involved in assigning these Values?

Consultation workshops were held to initially discuss how the environmental values might be calculated from the available data and to obtain feedback on the results of these calculations. These initial draft environmental values were then mapped and forwarded to a wide range of stakeholders for wider feedback with face-to-face feedback discussions held with a selection of representative organisations to promote more comprehensive input.

Organisations whose representatives provided feedback on the draft values include:

- Department of Environment and Resource Management
- Department of Employment, Education, Development and Innovation
- Toowoomba Regional Council
- Western Downs Regional Council
- Southern Downs Regional Council
- Murray Darling Basin Authority
- Growcom
- Australian Lot Feeders Association
- Queensland Dairyfarmers Organisation
- Cotton Australia
- Landcare
- AgForce

Other organisations invited to provide feedback include:

- Queensland Egg Farmers Association
- Queensland Pork Producers Inc
- Oakey Freshwater Fishstocking Association
- Central Downs Irrigators
- Charleys Creek Basin Water Advisory Committee
- Cunningham irrigators

Where to from here?

The current round of consultation aims to fill some gaps in the previous consultation to improve the completeness of the information prior to release of the draft environmental values for use in development of water quality guidelines and objectives.

Stakeholders to be engaged for feedback in this round of consultation include:

- Mining and extractive industries
- Aboriginal and traditional owner community
- Commerce

You are invited to provide feedback on the draft environmental values to improve their representation of the full 'community' of the catchment.

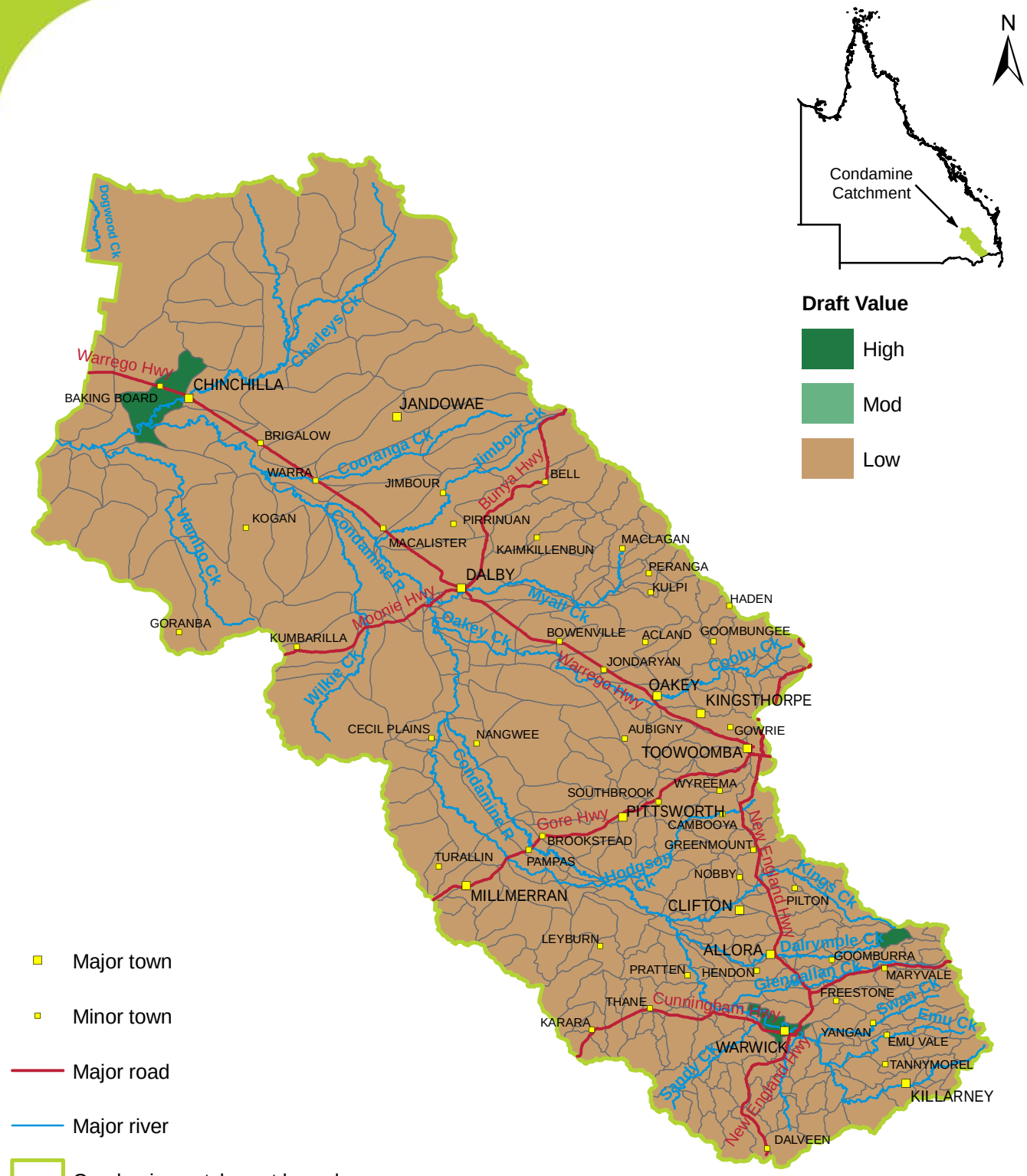
Feedback can be provided in a number of ways, but the key information required to make any amendments are a location (e.g. the relevant subcatchment/aquifer number) and the change required for that location. This can be provided as text via email or post, or via mark-up of the hardcopy maps included in this package.

Feedback should be forwarded to Lucy Richardson at PO Box 238, Drayton North QLD 4350, or at lucy.richardson@condaminealliance.com.au. If you have any questions, Lucy can be reached on 07 4620 0115.

We thank you for your participation in the development of these environmental values as they will provide an important mechanism to protect the water needs and values of the Condamine catchment community into the future.

References

Department of Environment and Resource Management (2009) *Queensland Water Quality Guidelines*, Version 3, ISBN 978-0-9806986-0-2 available at: http://www.epa.qld.gov.au/environmental_management/water/queensland_water_quality_guidelines/



NOTE: This value was determined through the presence/ absence of licences for extraction of surface water for aquaculture use and through community feedback.

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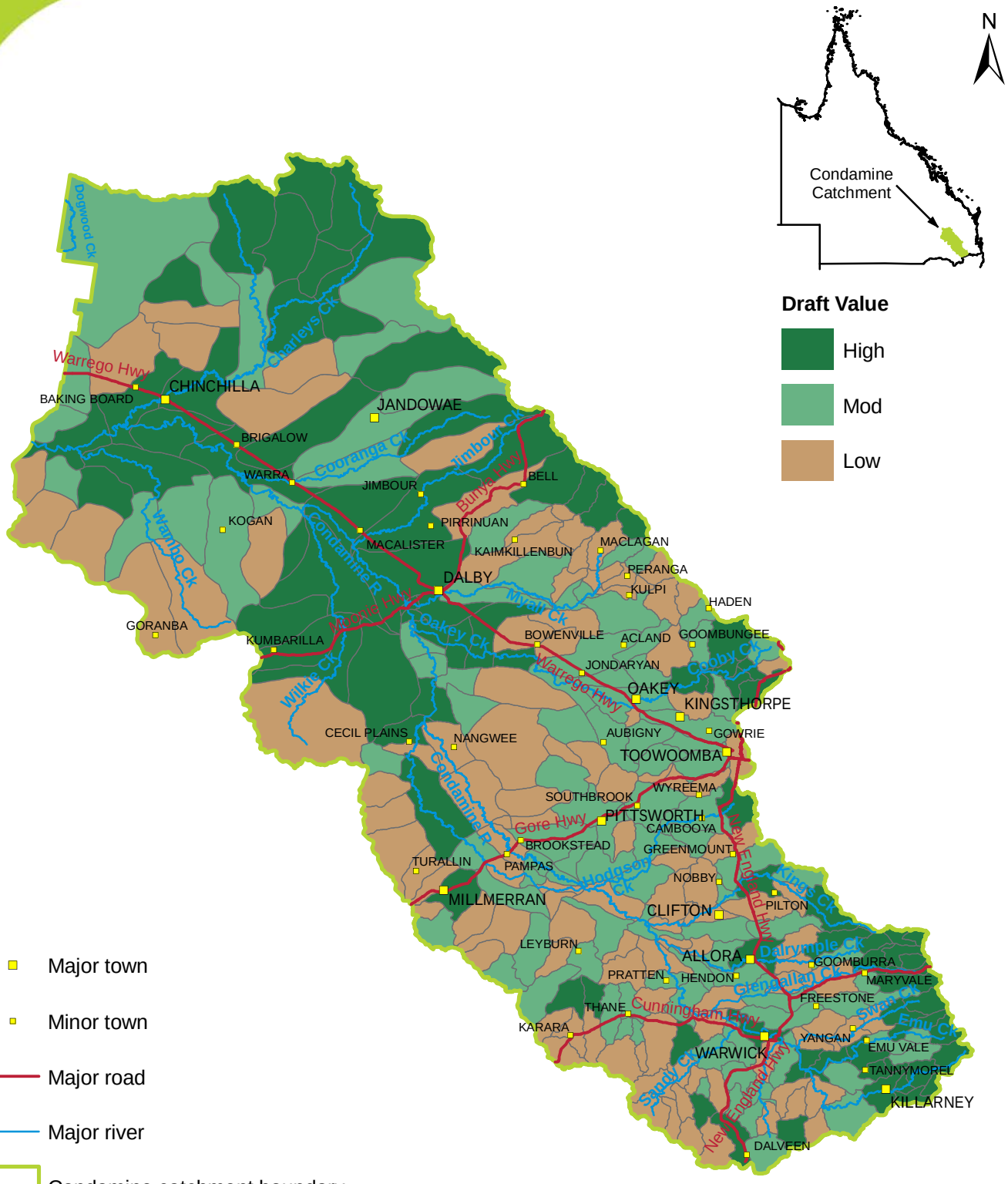
Q2 Coasts and Country

Map 1

Draft Aquaculture Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-23 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through interpretation of the Aquatic Conservation Assessment undertaken by Department of Environment and Resource Management with the addition of the Dewfish Demonstration Reach and the Headwaters Rehabilitation Reach and through community feedback.

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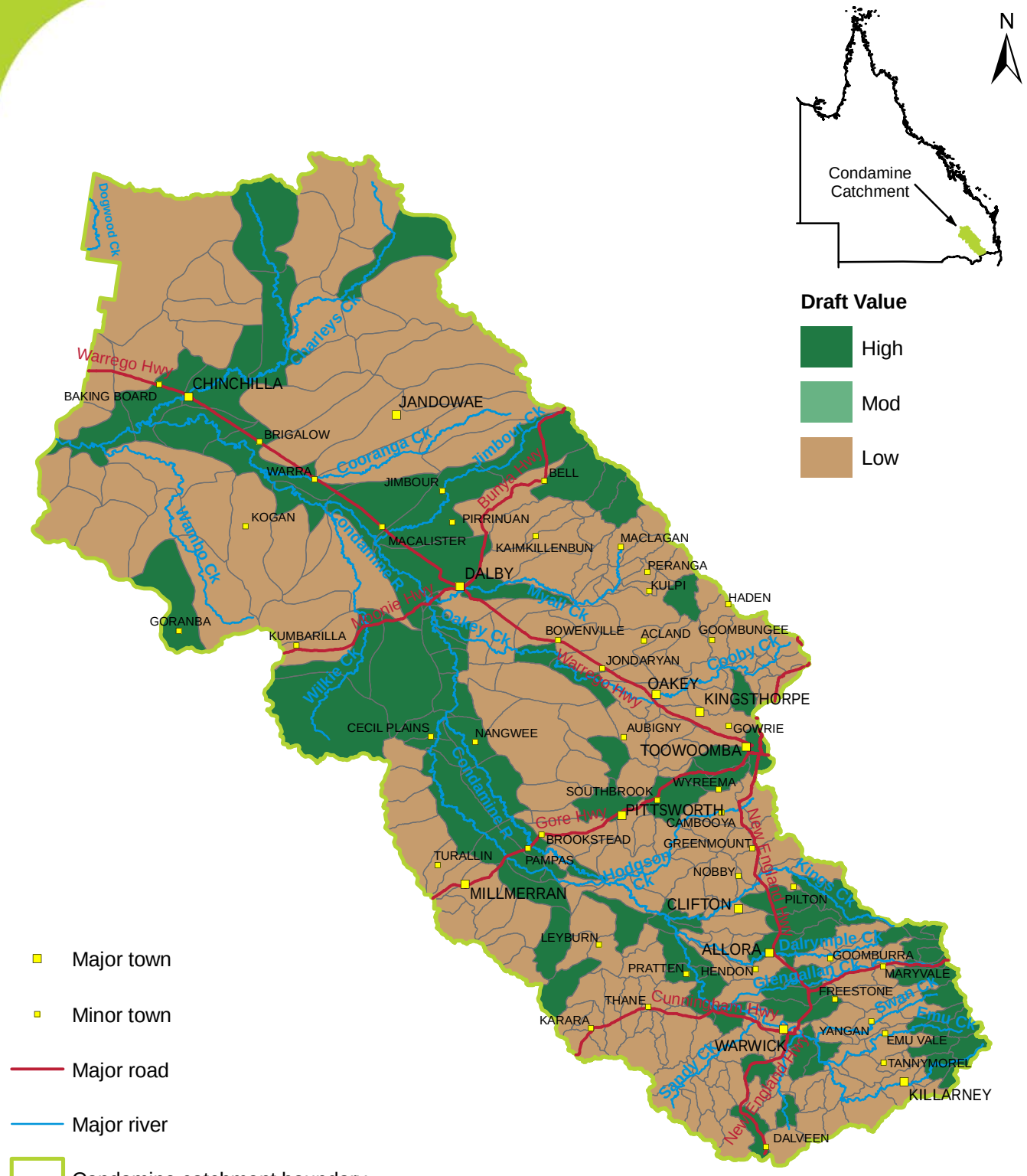
Map 2

Draft Aquatic Ecosystem Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-24 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined using locations of known springs, National Parks and reserves, mostly permanent wetlands, and known sites of Aboriginal or European cultural significance and through community feedback.

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Map 3

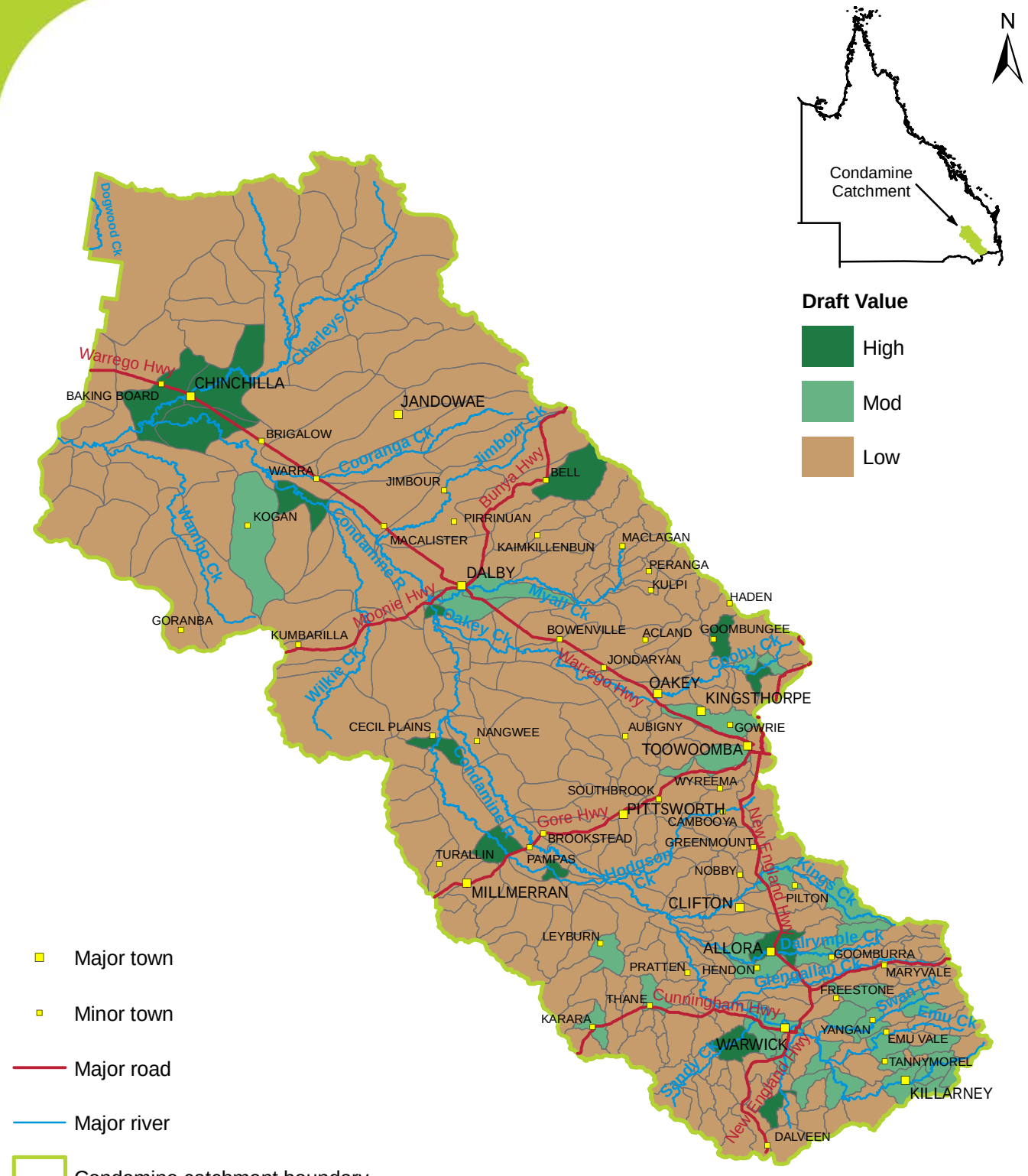
Draft Cultural & Spiritual Value

Environmental Values

Surface Water

Condamine Catchment

Filename: LR2010-25 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through presence/absence of surface water extraction licences for town water and domestic supply (including weirs and dams) and through community feedback.

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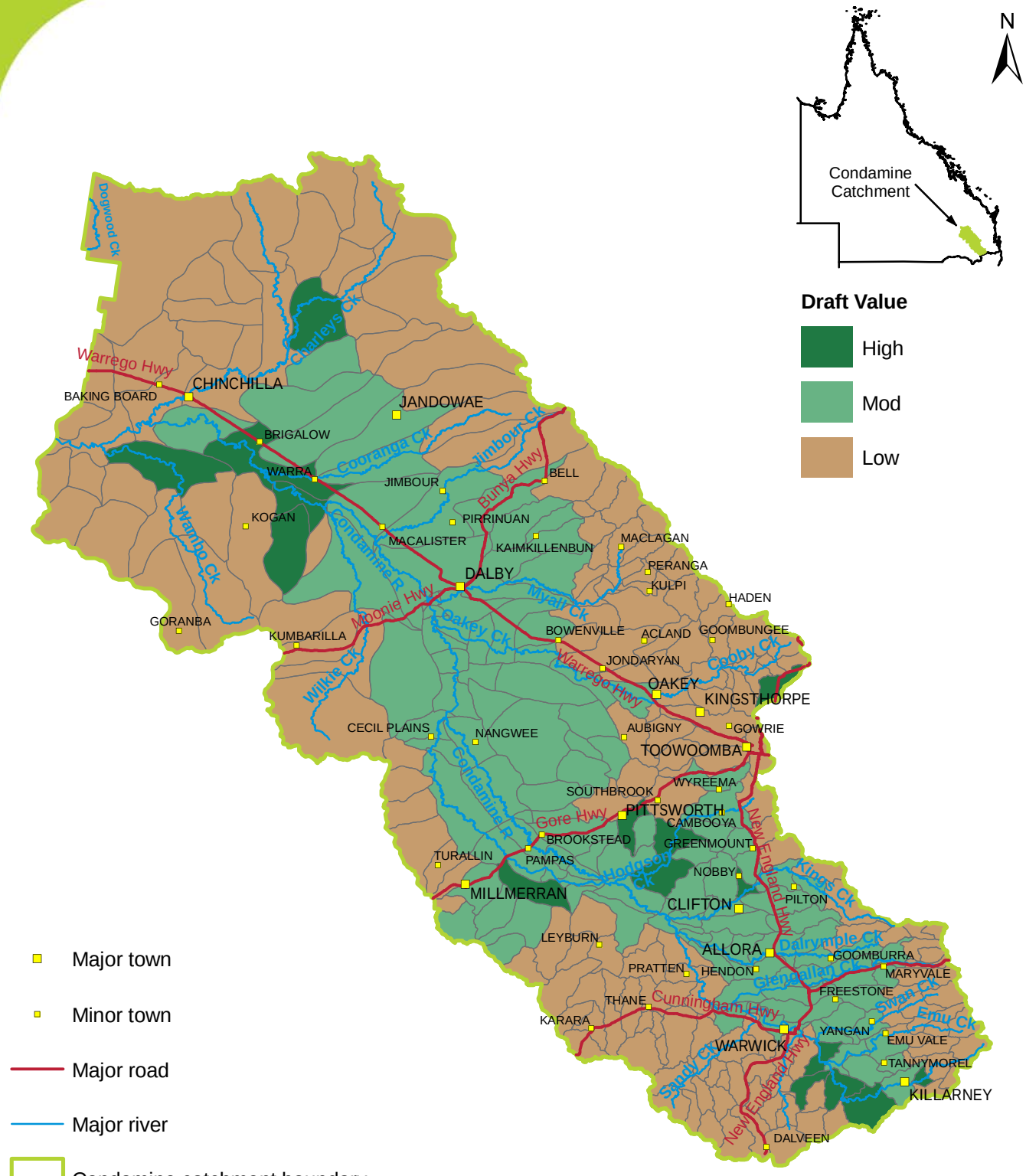
Map 4

Draft Drinking Water Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-26 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through presence/ absence of surface water extraction licences for intensive livestock, and through identification of dominant cropping land where crop spraying and associated water uses exist and through community feedback.

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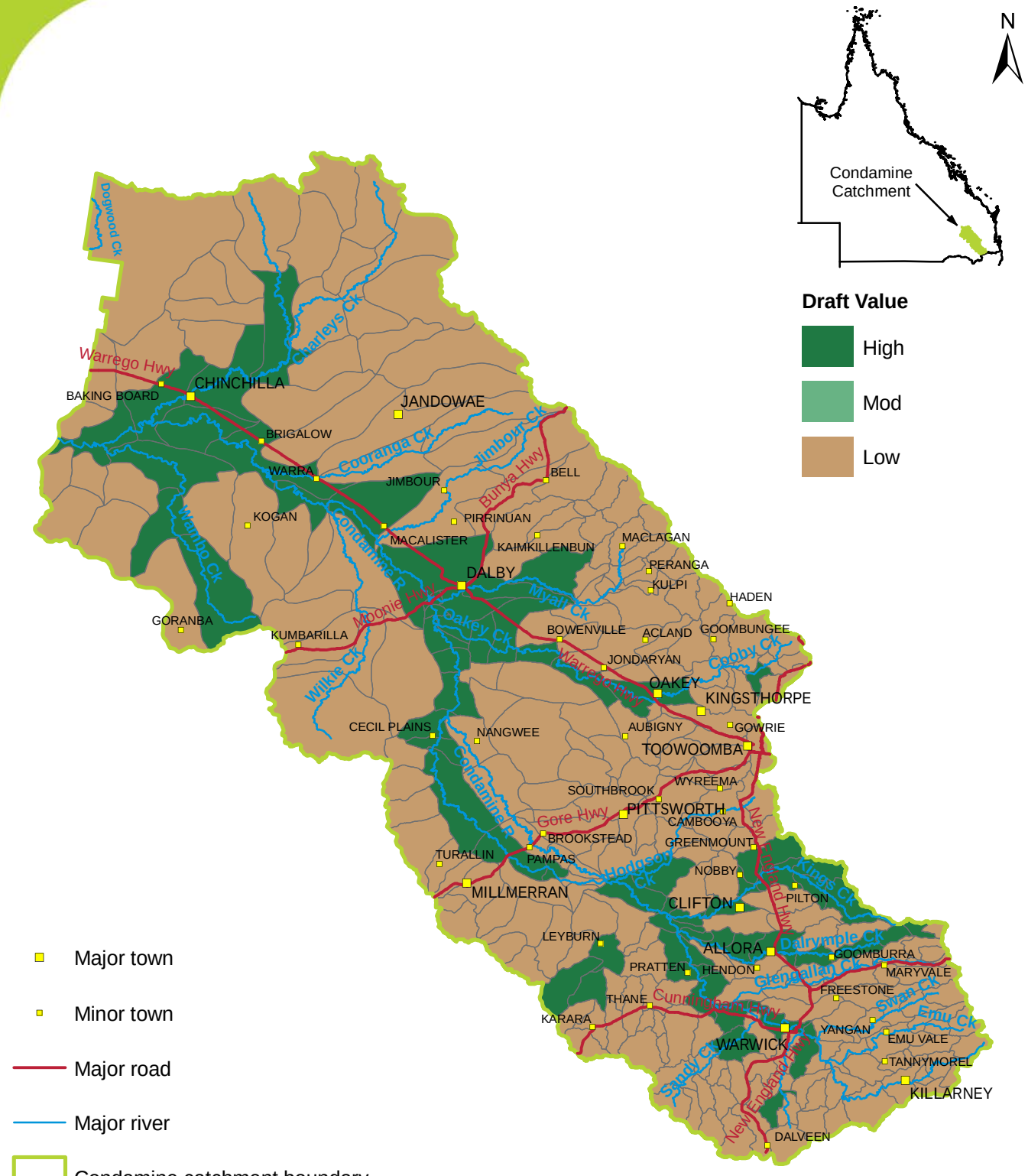
Map 5

Draft Farm Supply Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-27 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through presence/ absence of known recreational fishing locations and through community feedback.

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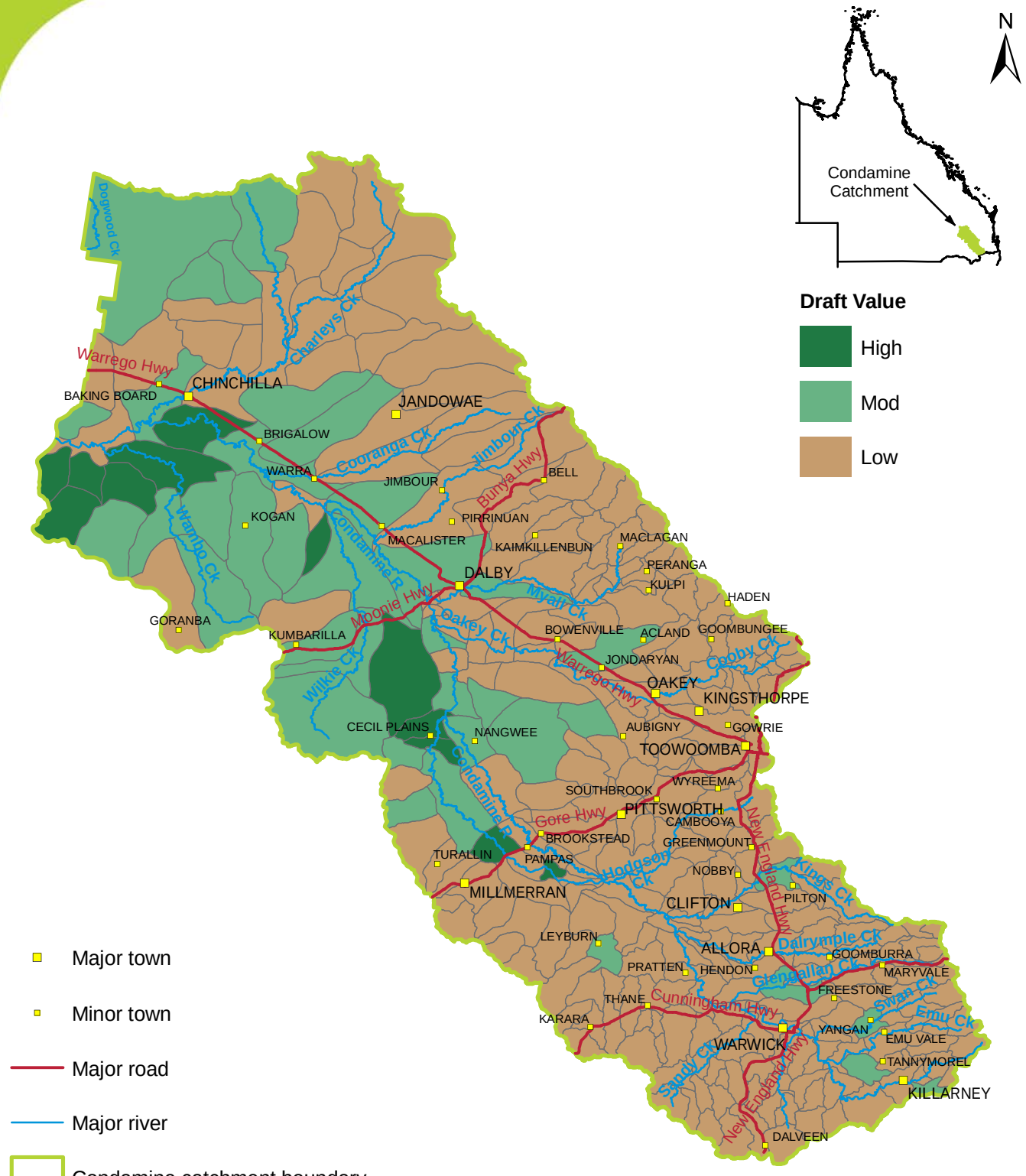
Map 6

Draft Human Consumption Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-28 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through presence/absence of surface water extraction licences for industrial use and the density of mining wells and through community feedback.

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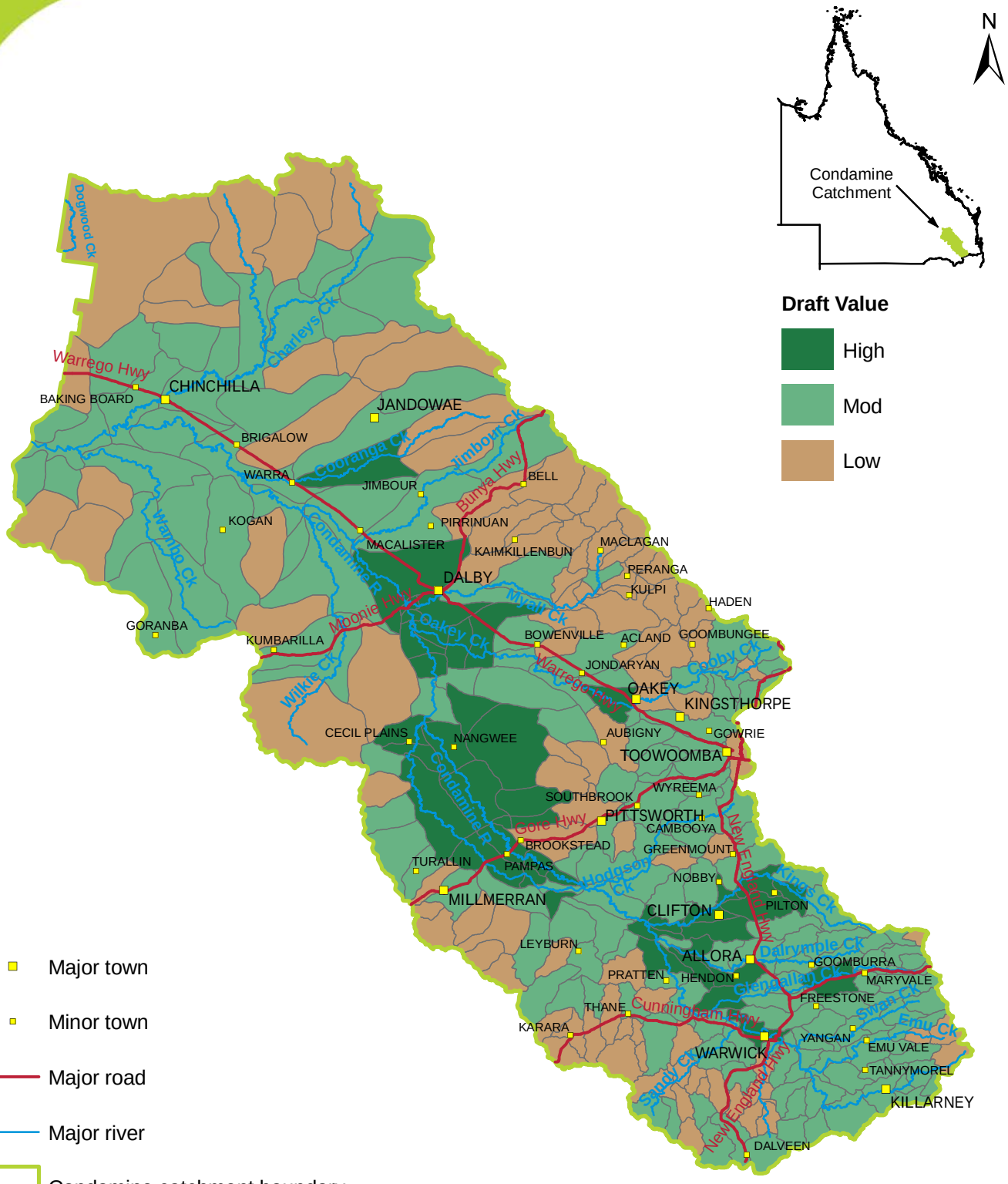
Map 7

Draft Industrial Use Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-29 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the proportion of area irrigated and the presence/absence of surface water extraction licences for irrigation use and through community feedback.

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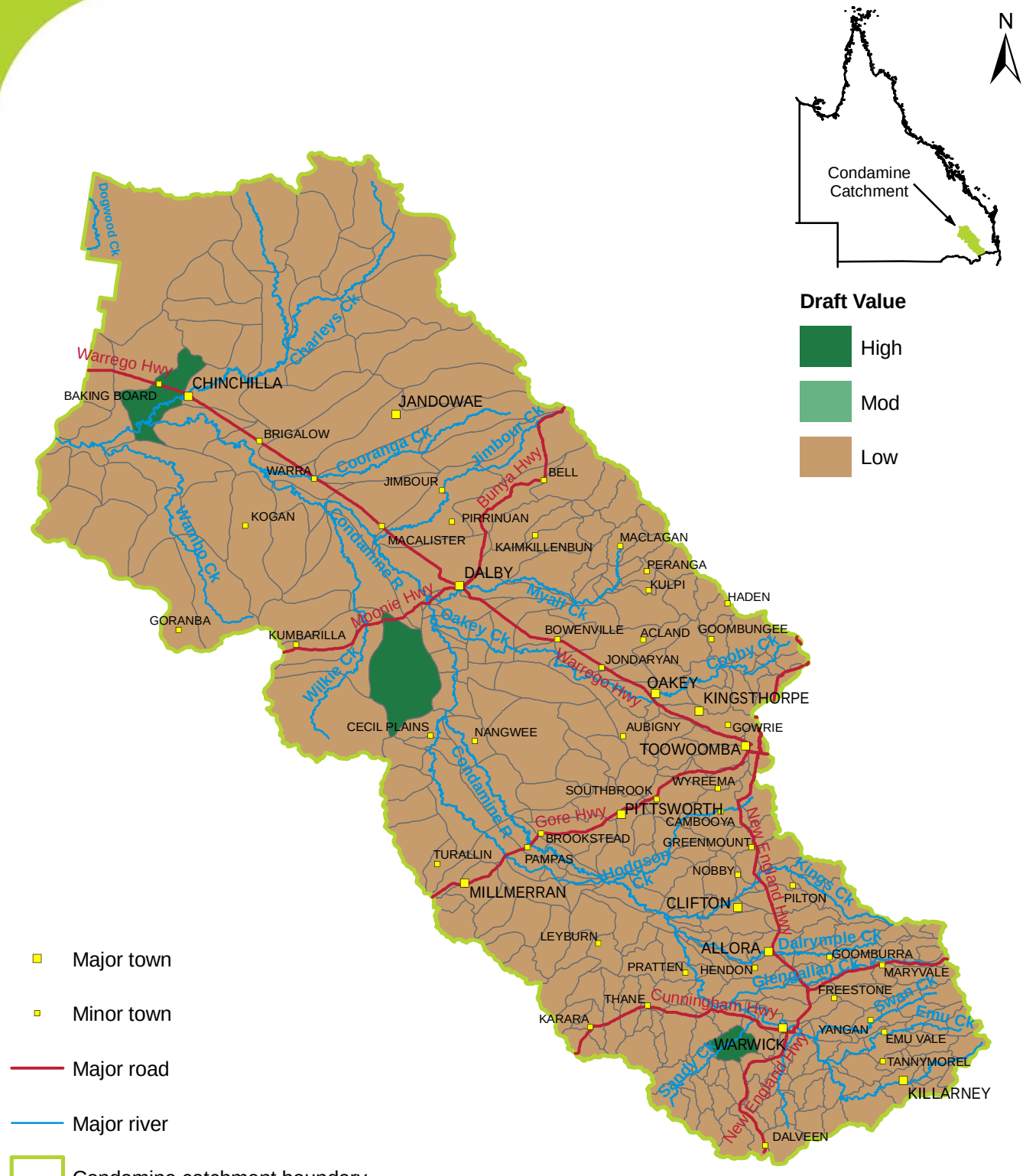
Map 8

Draft Irrigation Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-30 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of areas approved for primary recreation and through community feedback.

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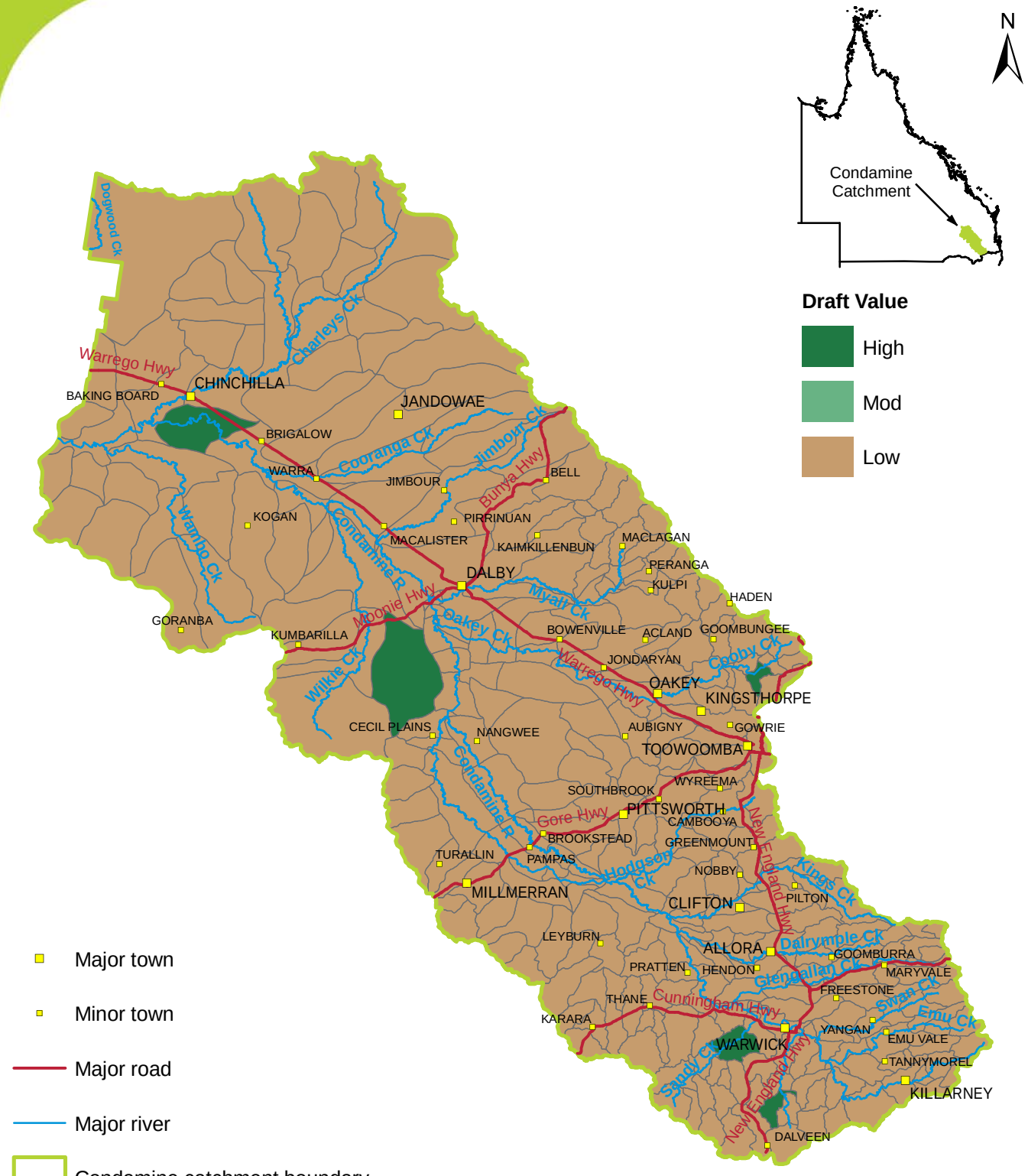
Map 9

Draft Primary Recreation Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-31 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of areas approved for secondary recreation and through community feedback.

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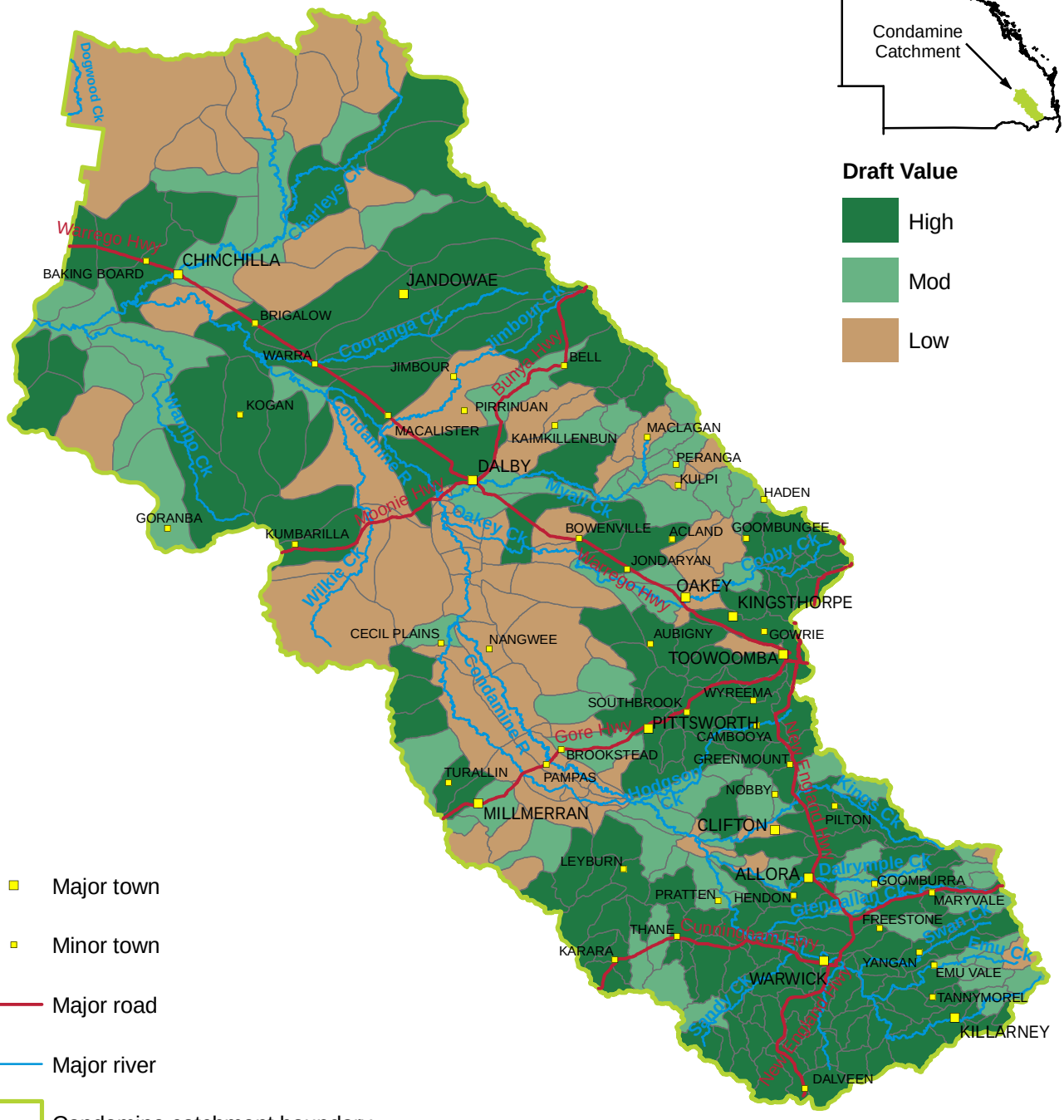
Map 10

Draft Secondary Recreation Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-32 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the proportion of grazing area and the density of horse ownership and through community feedback.

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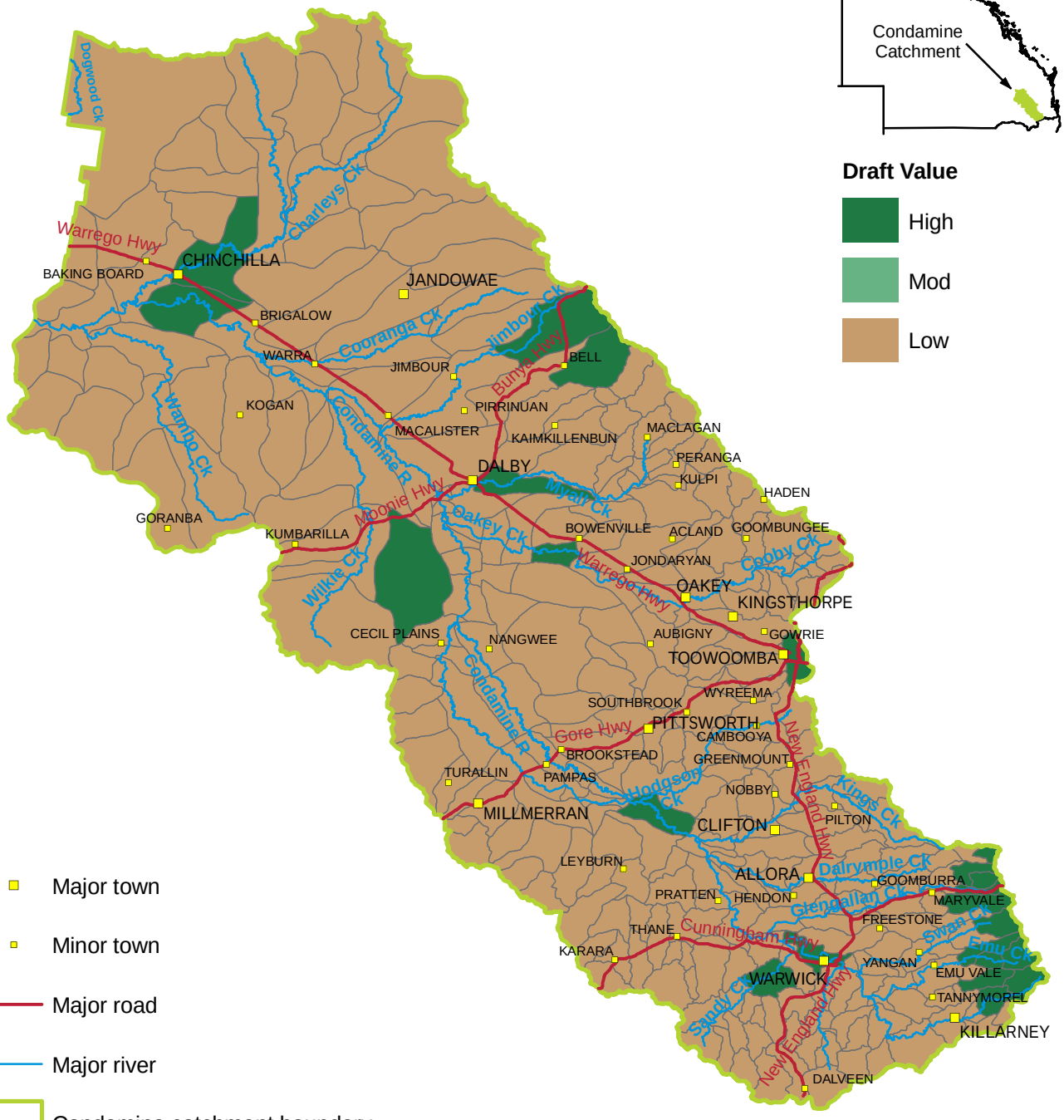
Map 11

Draft Stock Watering Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-33 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of National Parks and reserves and other known areas of tertiary recreation and through community feedback.

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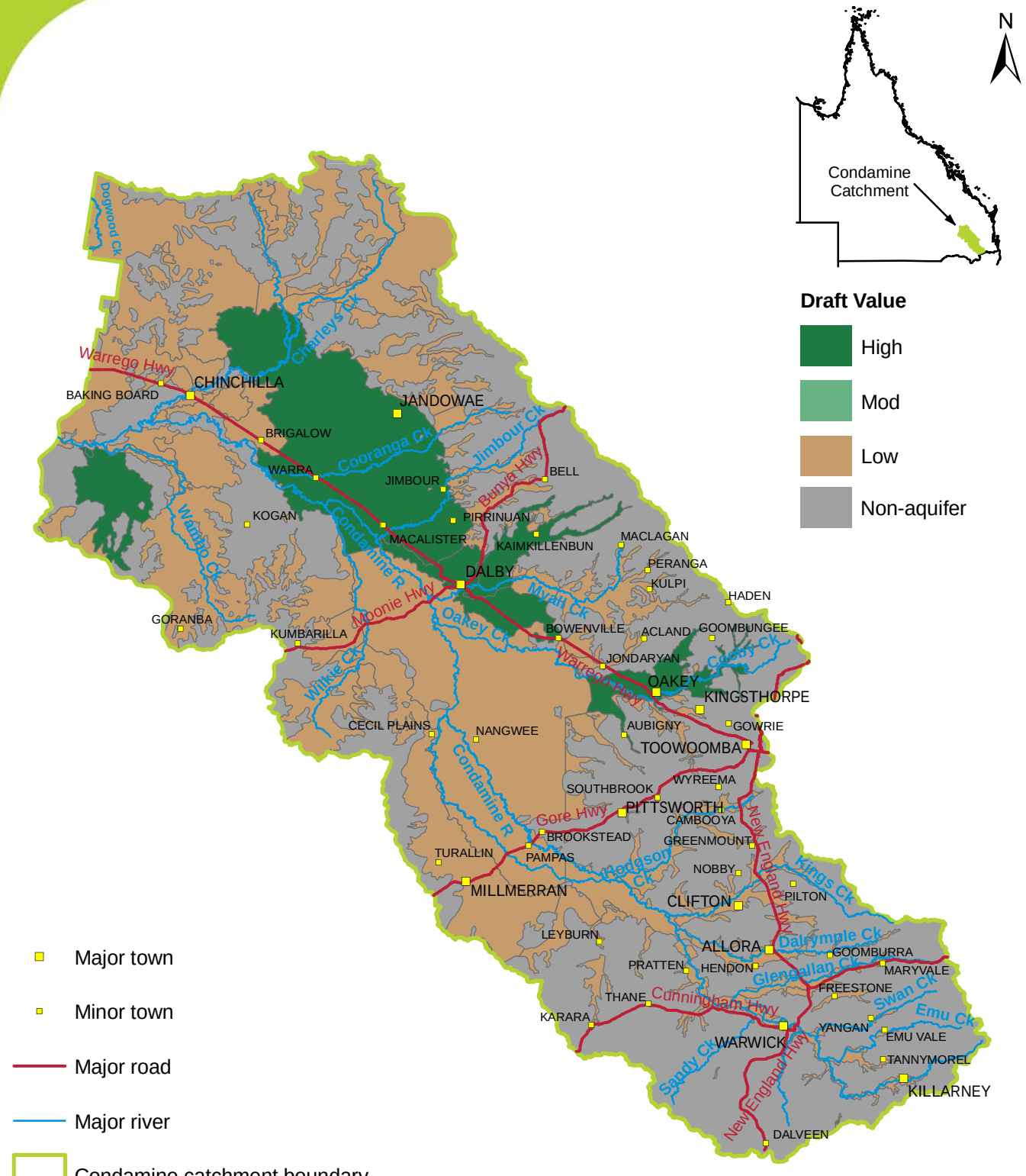
Map 12

Draft Visual Appreciation Value
Environmental Values
Surface Water
Condamine Catchment

Filename: LR2010-34 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for aquaculture and through community feedback.

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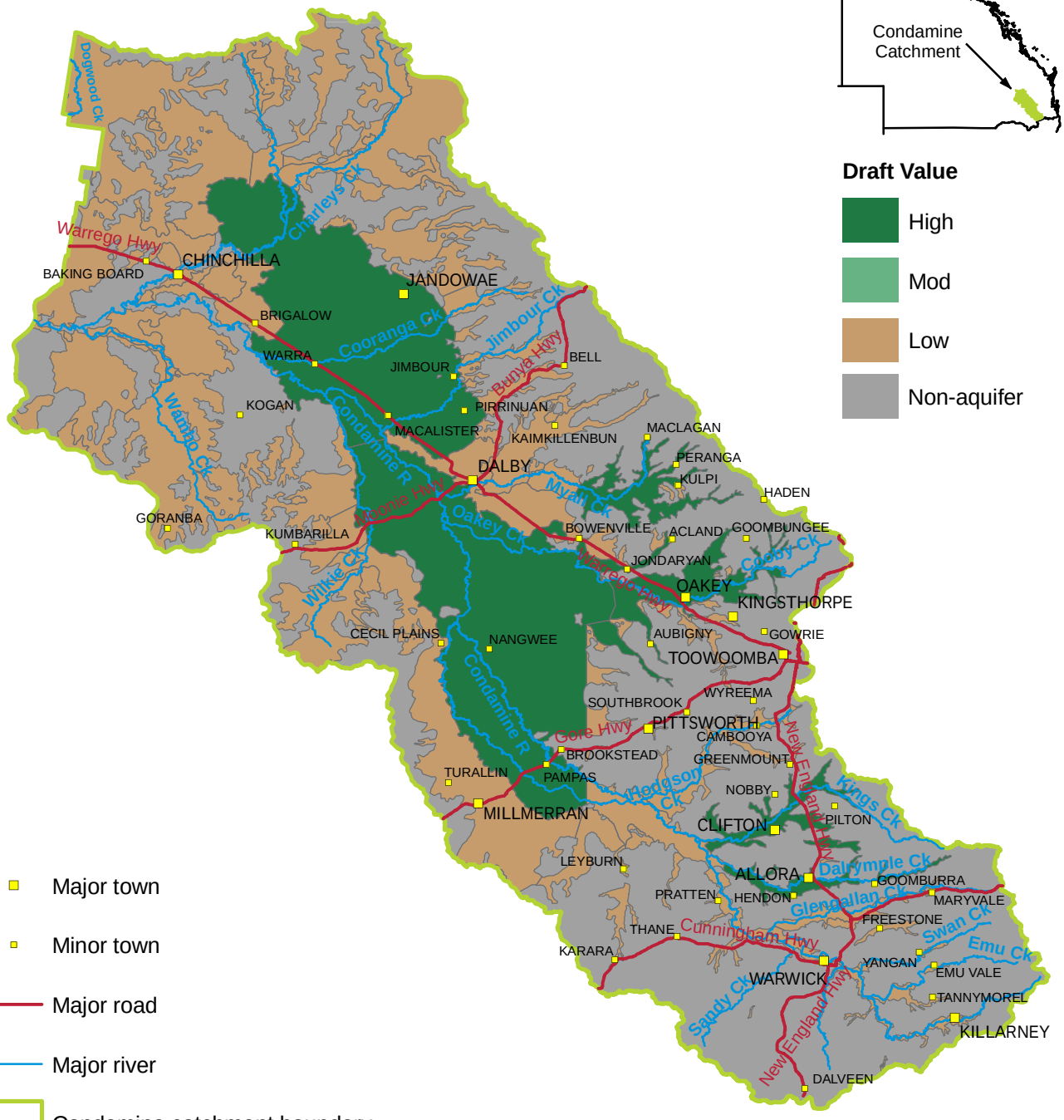
Map 13

Draft Aquaculture Value
Environmental Values
Condamine Alluvium
Condamine Catchment

Filename: LR2010-35 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater springs, known populations of stygofauna and through community feedback.

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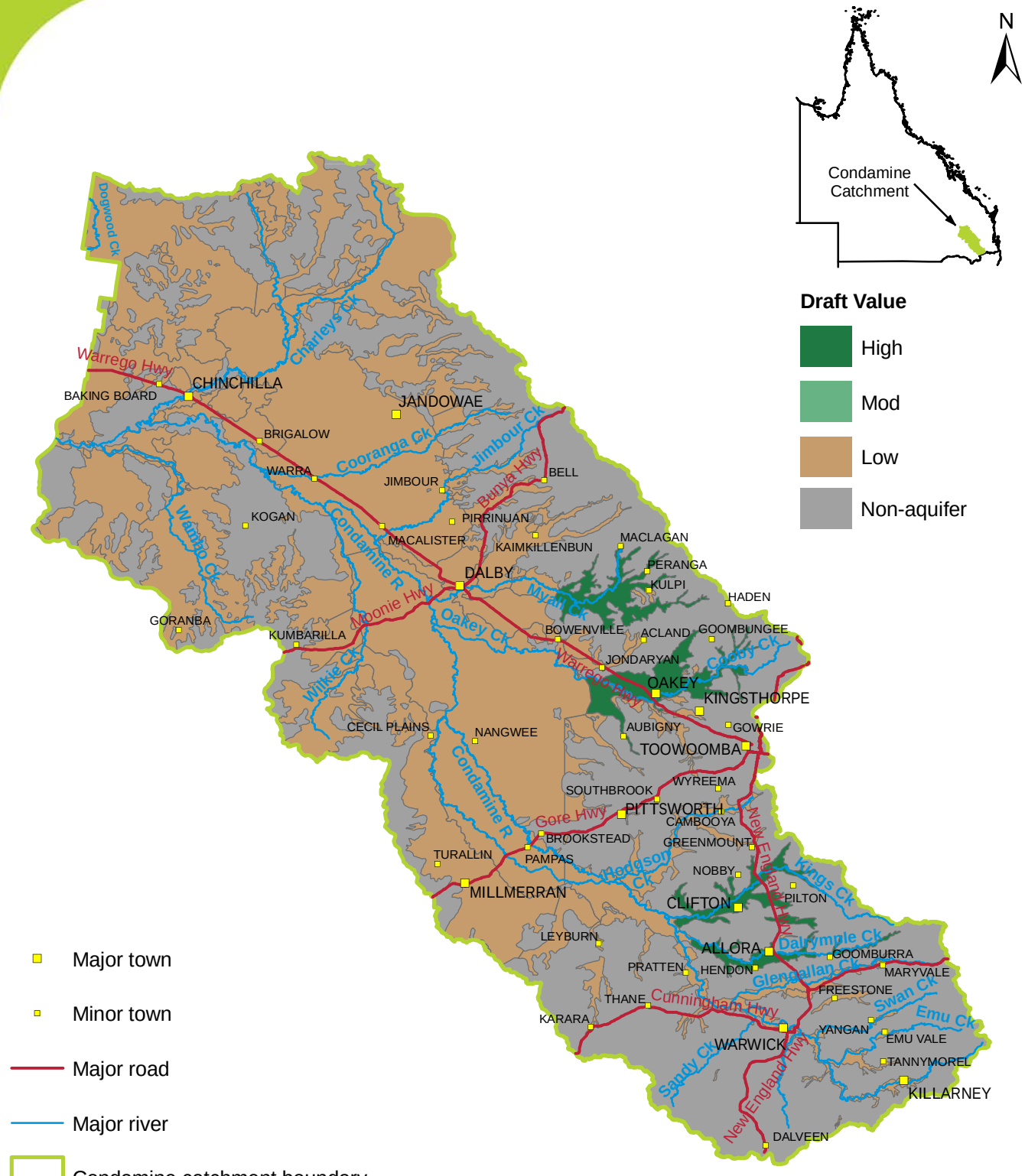
Map 14

Draft Aquatic Ecosystem Value
Environmental Values
Condamine Alluvium
Condamine Catchment

Filename: LR2010-36 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater springs and through community feedback.

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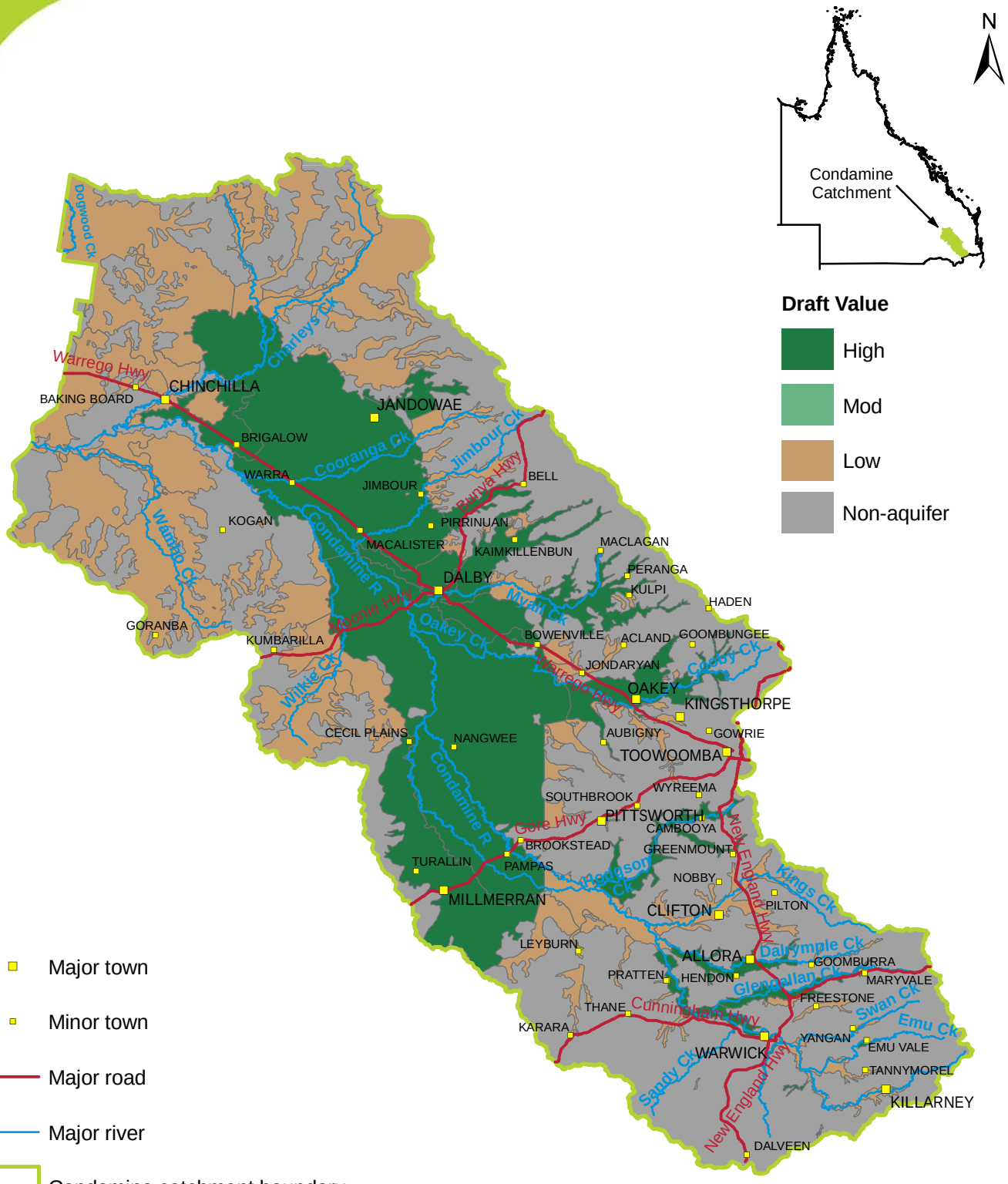
Map 15

Draft Cultural & Spiritual Value
Environmental Values
Condamine Alluvium
Condamine Catchment

Filename: LR2010-37 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for town water and domestic supply and through community feedback.

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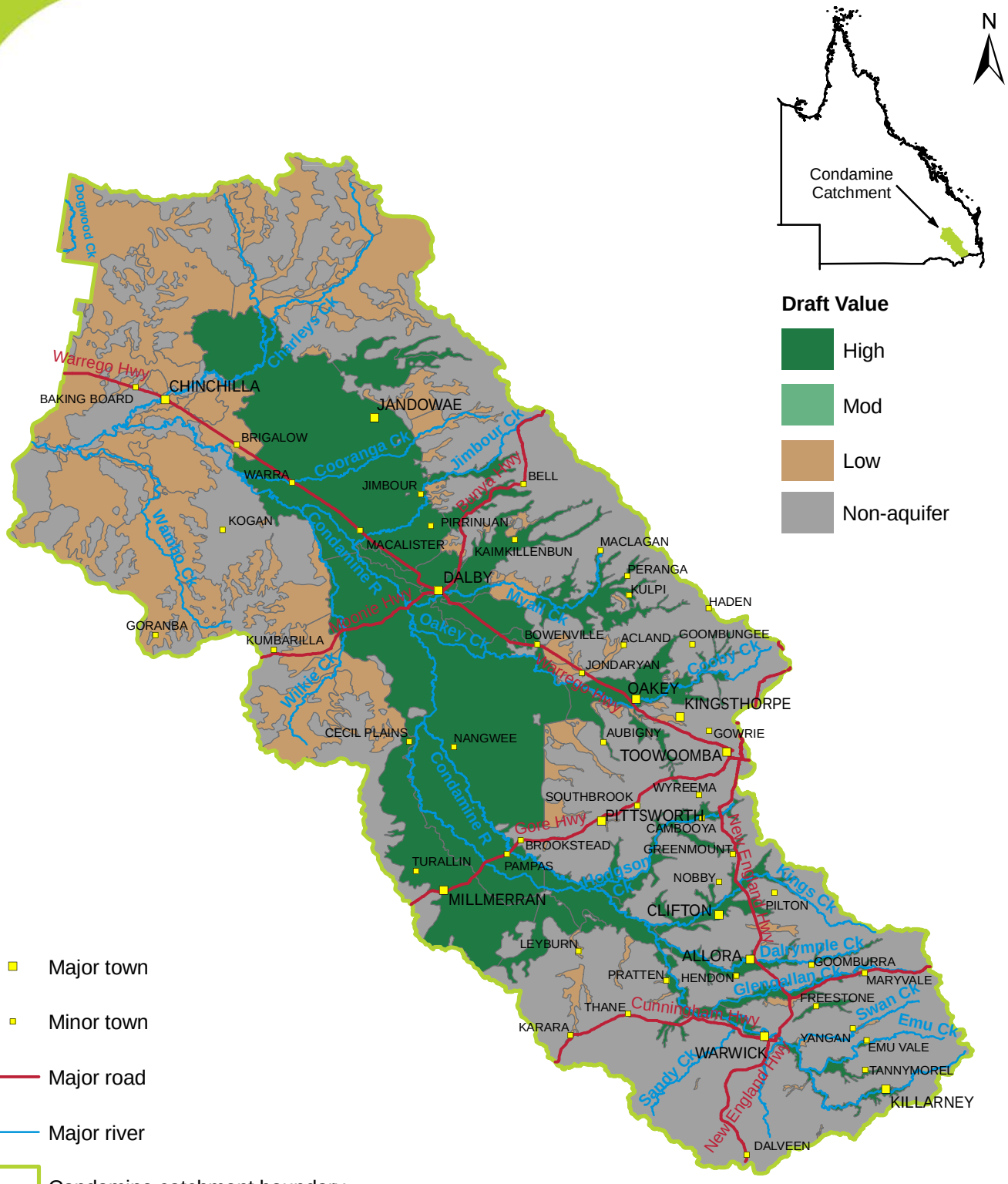
Map 16

Draft Drinking Water Value
Environmental Values
Condamine Alluvium
Condamine Catchment

Filename: LR2010-38 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for intensive livestock and through community feedback.

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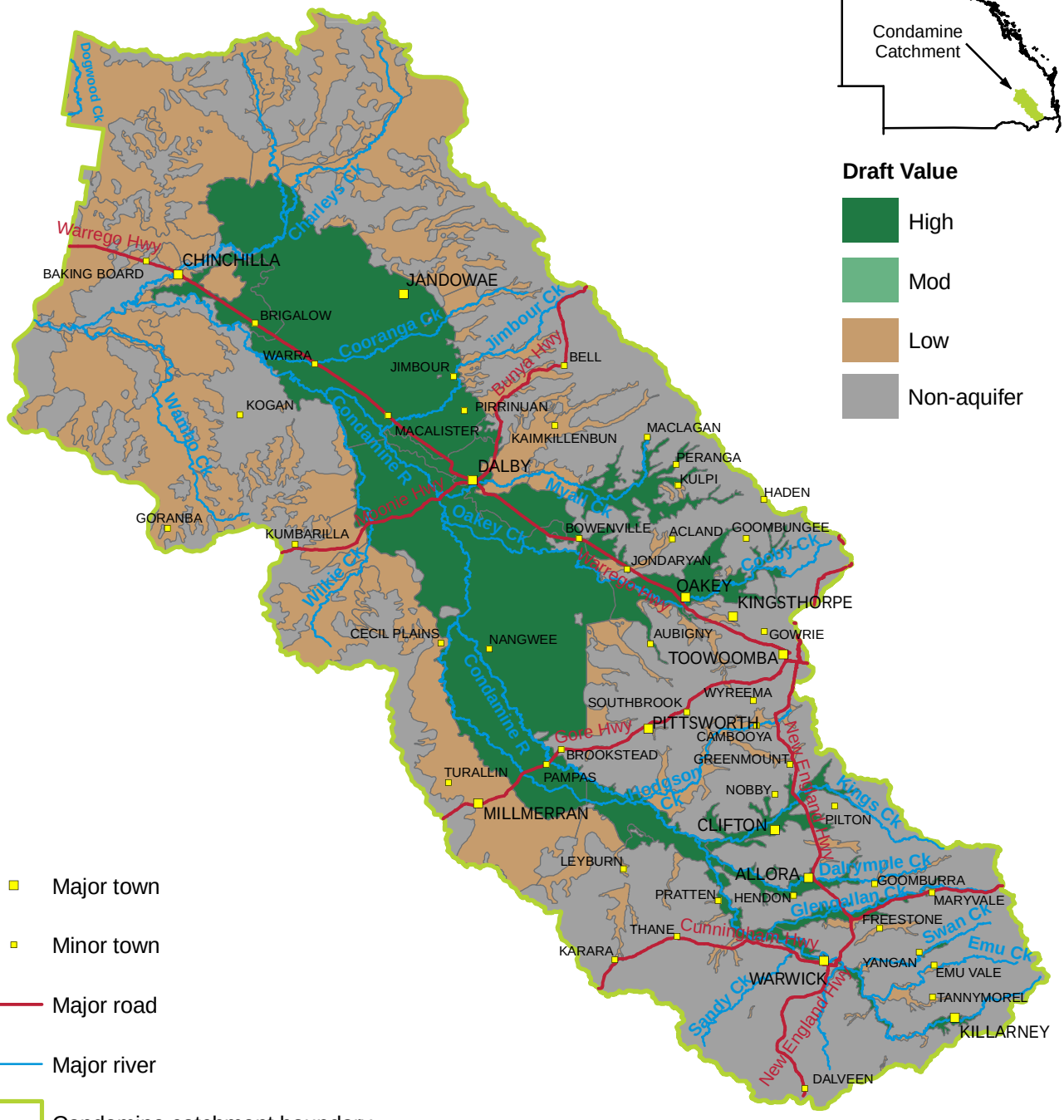
Map 17

Draft Farm Supply Value
Environmental Values
Condamine Alluvium
Condamine Catchment

Filename: LR2010-39 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for industrial and commercial uses and through community feedback.

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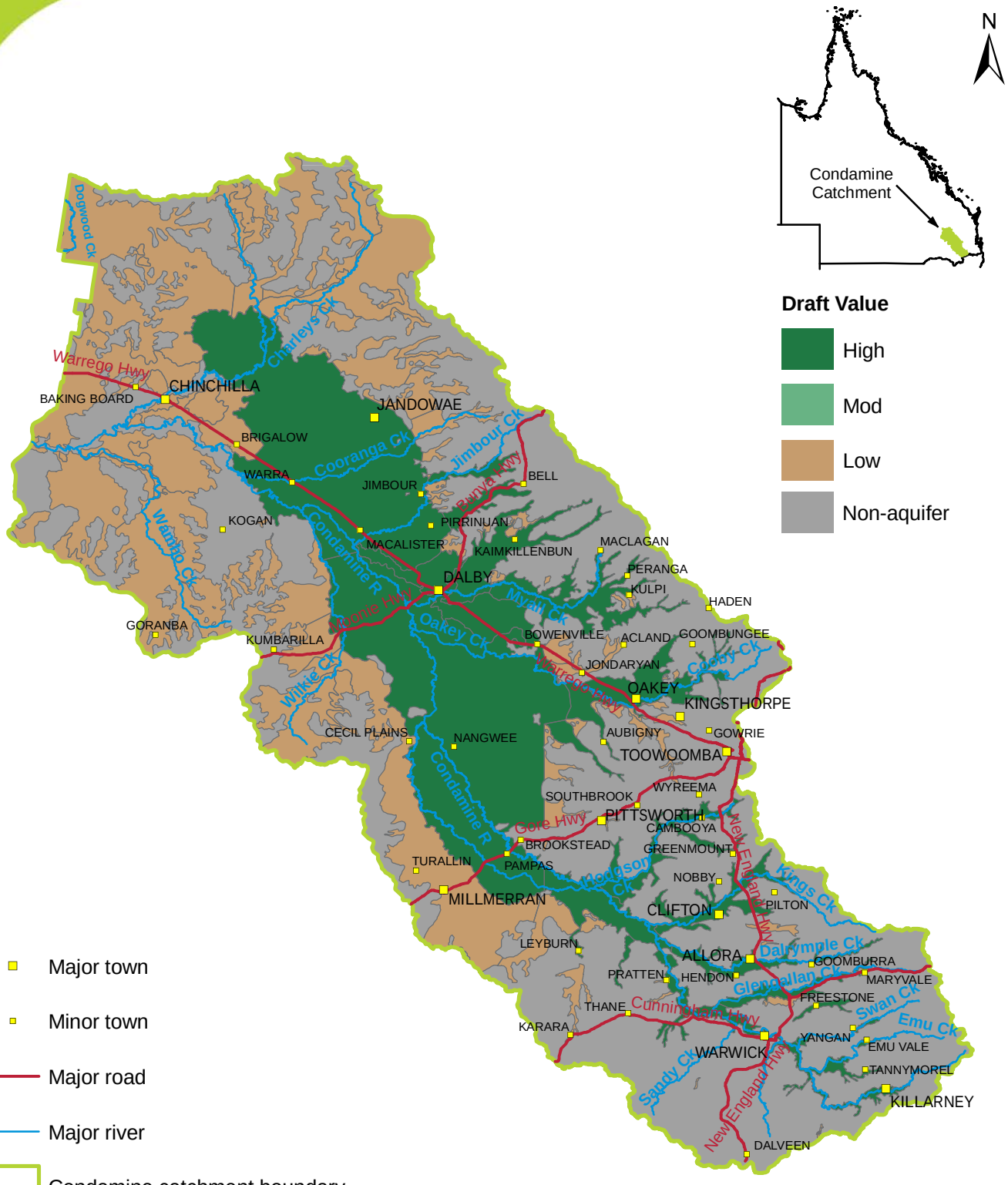
Map 18

Draft Industrial Use Value
Environmental Values
Condamine Alluvium
Condamine Catchment

Filename: LR2010-40 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for irrigation and through community feedback.

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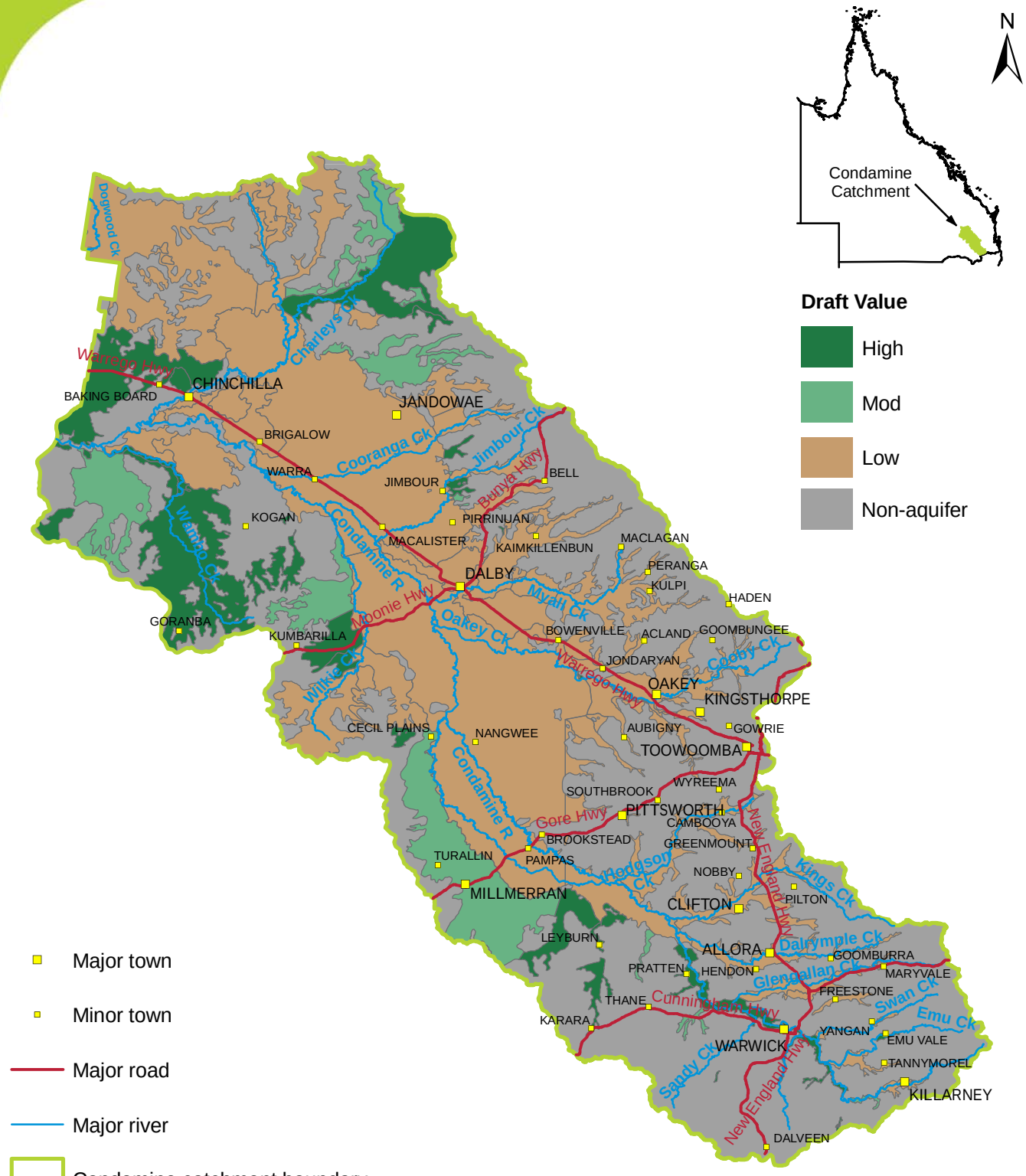
Map 19

Draft Irrigation Value
Environmental Values
Condamine Alluvium
Condamine Catchment

Filename: LR2010-41 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for stock watering and through community feedback.

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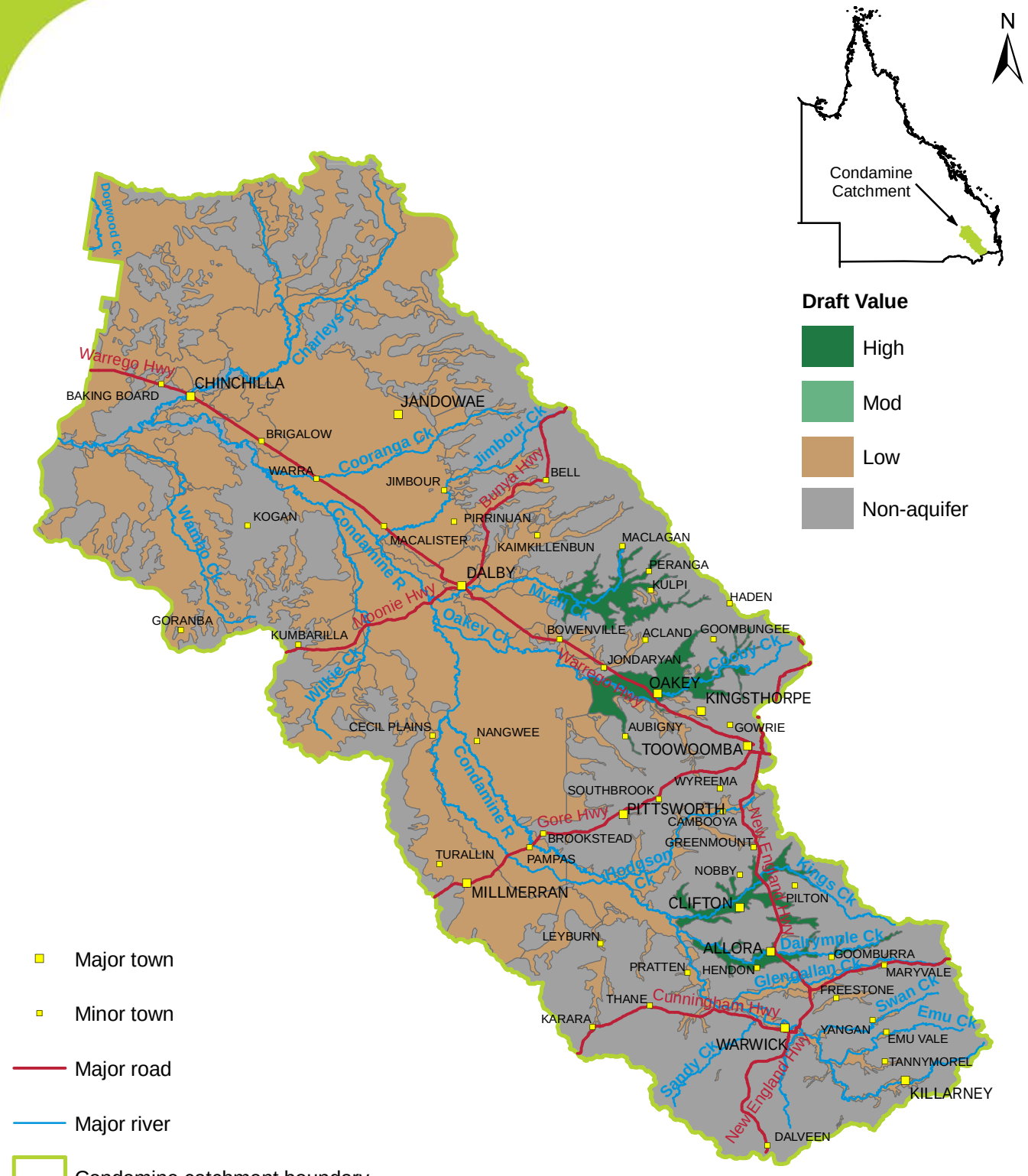
Map 20

Draft Stock Watering Value
Environmental Values
Condamine Alluvium
Condamine Catchment

Filename: LR2010-42 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of known groundwater springs and through community feedback.

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Map 21

Draft Visual Appreciation Value
Environmental Values
Condamine Alluvium
Condamine Catchment

Filename: LR2010-43 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10

NOTE: This value was determined through the presence/ absence of groundwater extraction licences for aquaculture use and through community feedback.

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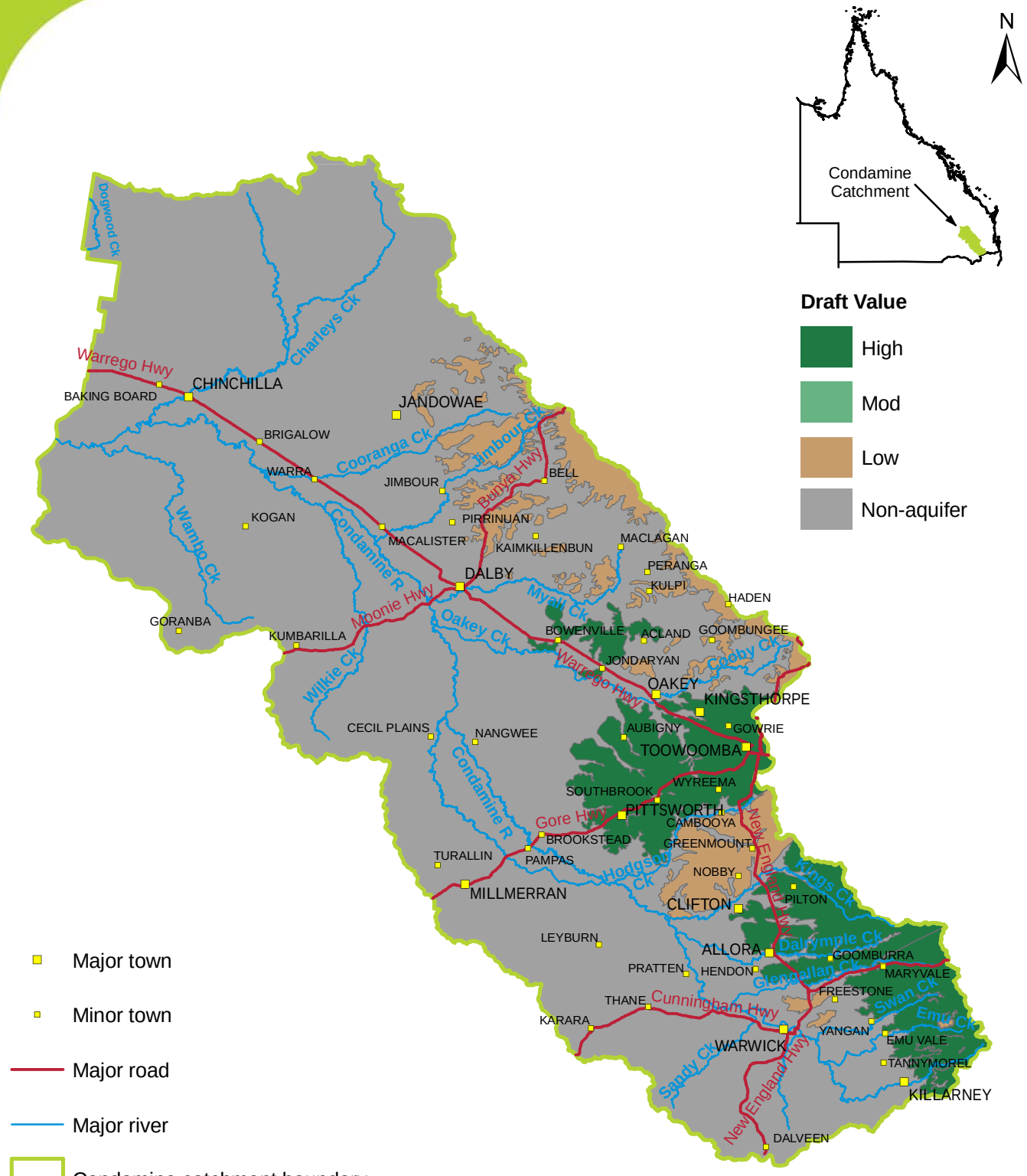
Map 22

Draft Aquaculture Value
Environmental Values
Main Range Volcanics
Condamine Catchment

Filename: LR2010-44 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of known groundwater springs and through community feedback.

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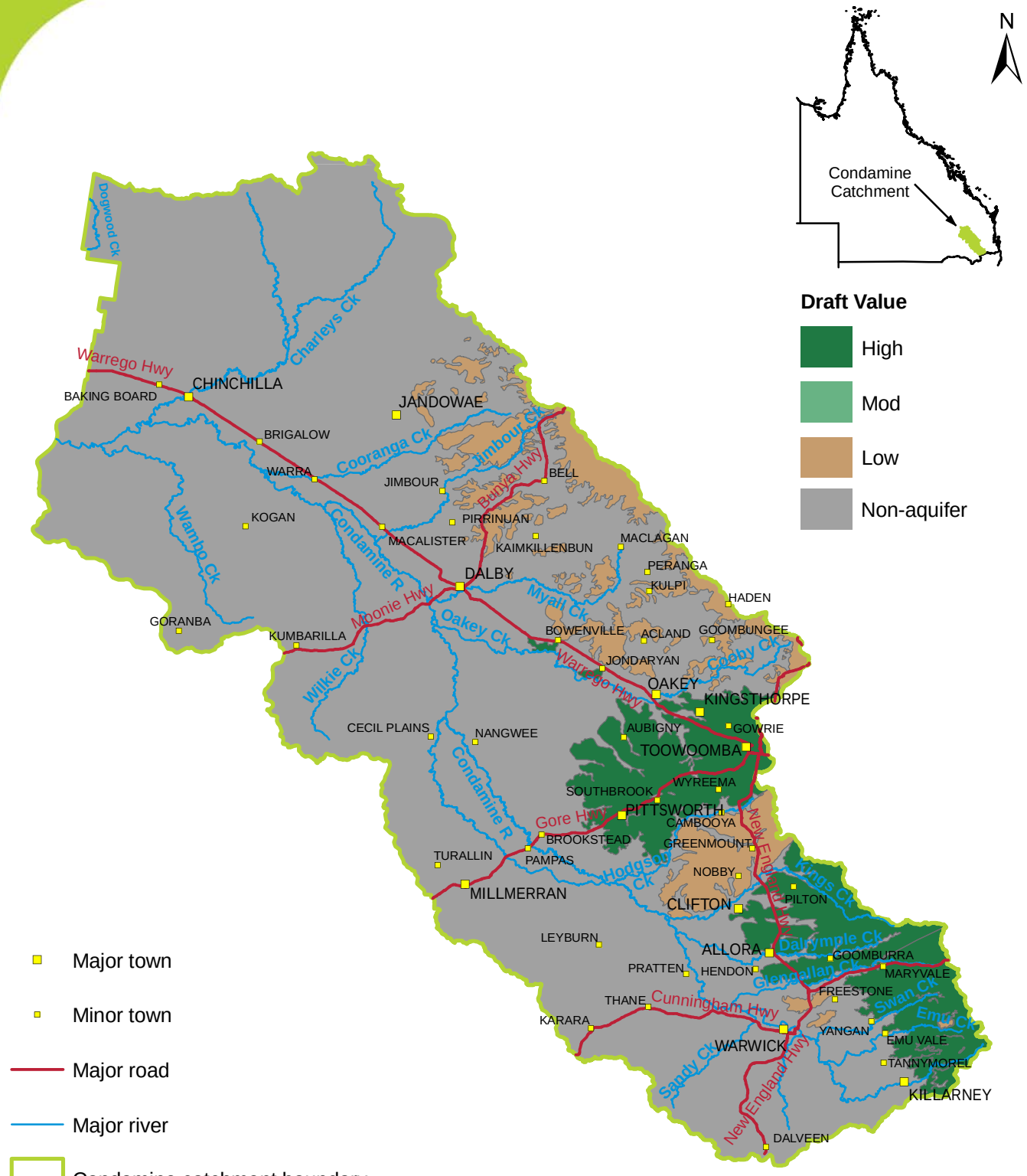
Map 23

Draft Aquatic Ecosystem Value
Environmental Values
Main Range Volcanics
Condamine Catchment

Filename: LR2010-45 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of known groundwater springs and through community feedback.

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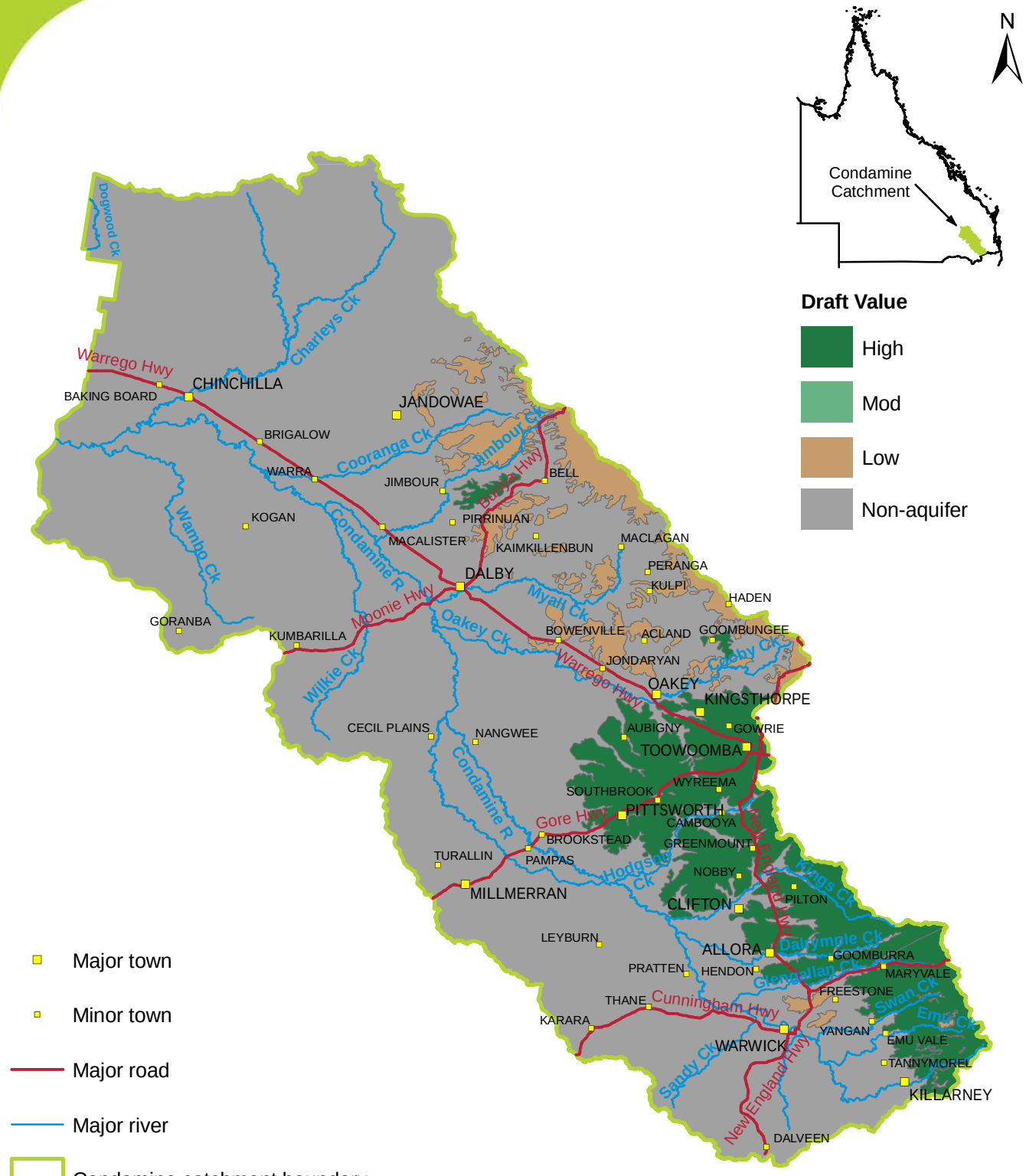
Map 24

Draft Cultural & Spiritual Value Environmental Values Main Range Volcanics Condamine Catchment

Filename: LR2010-46 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for town supply and domestic use and through community feedback.

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Map 25

Draft Drinking Water Value
Environmental Values
Main Range Volcanics
Condamine Catchment

Filename: LR2010-47 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10

NOTE: This value was determined through the presence/ absence of groundwater extraction licences for intensive livestock and through community feedback.

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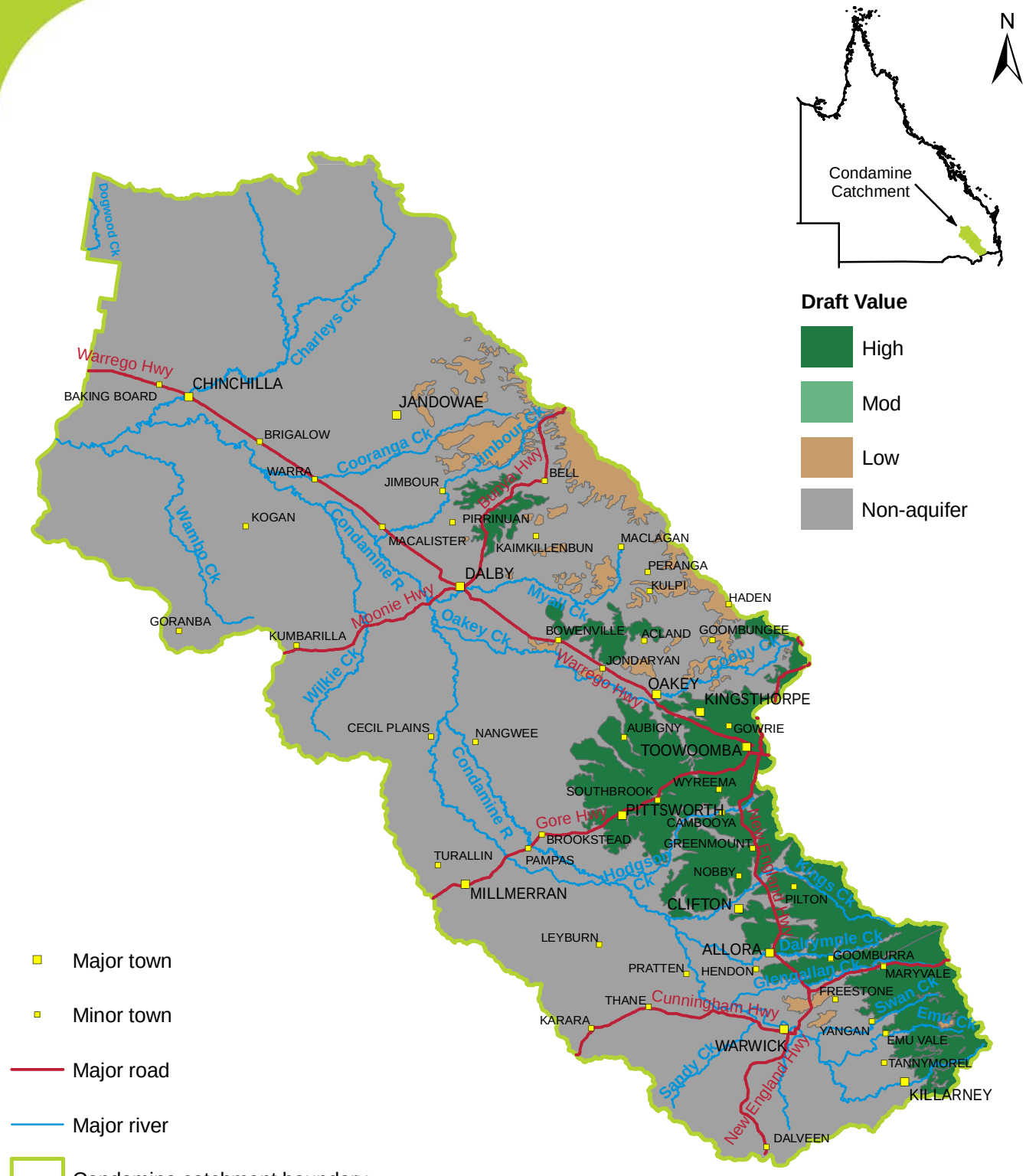
Map 26

Draft Farm Supply Value
Environmental Values
Main Range Volcanics
Condamine Catchment

Filename: LR2010-48 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for industrial or commercial uses and through community feedback.

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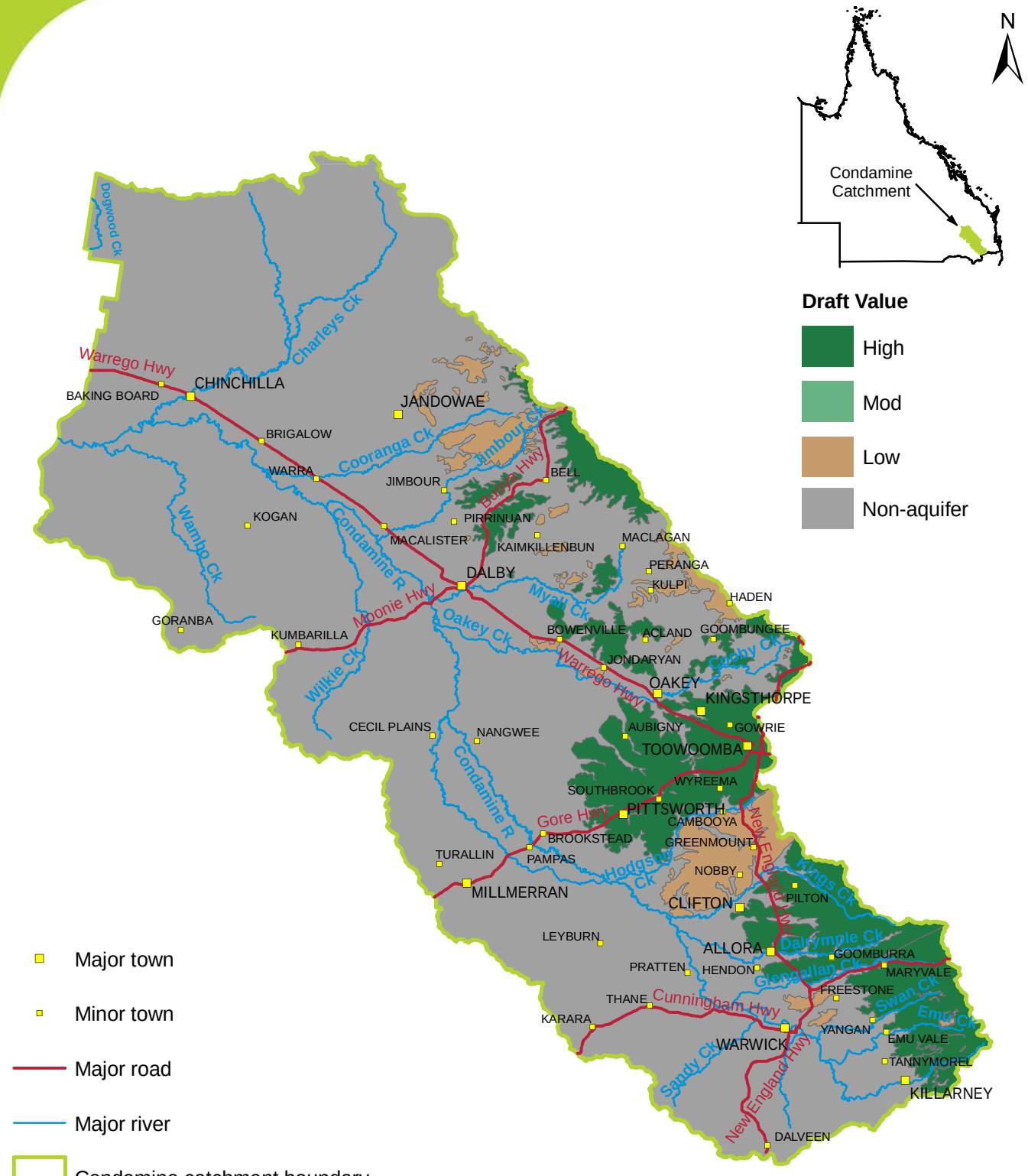
Map 27

Draft Industrial Use Value Environmental Values Main Range Volcanics Condamine Catchment

Filename: LR2010-49 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for irrigation use and through community feedback.

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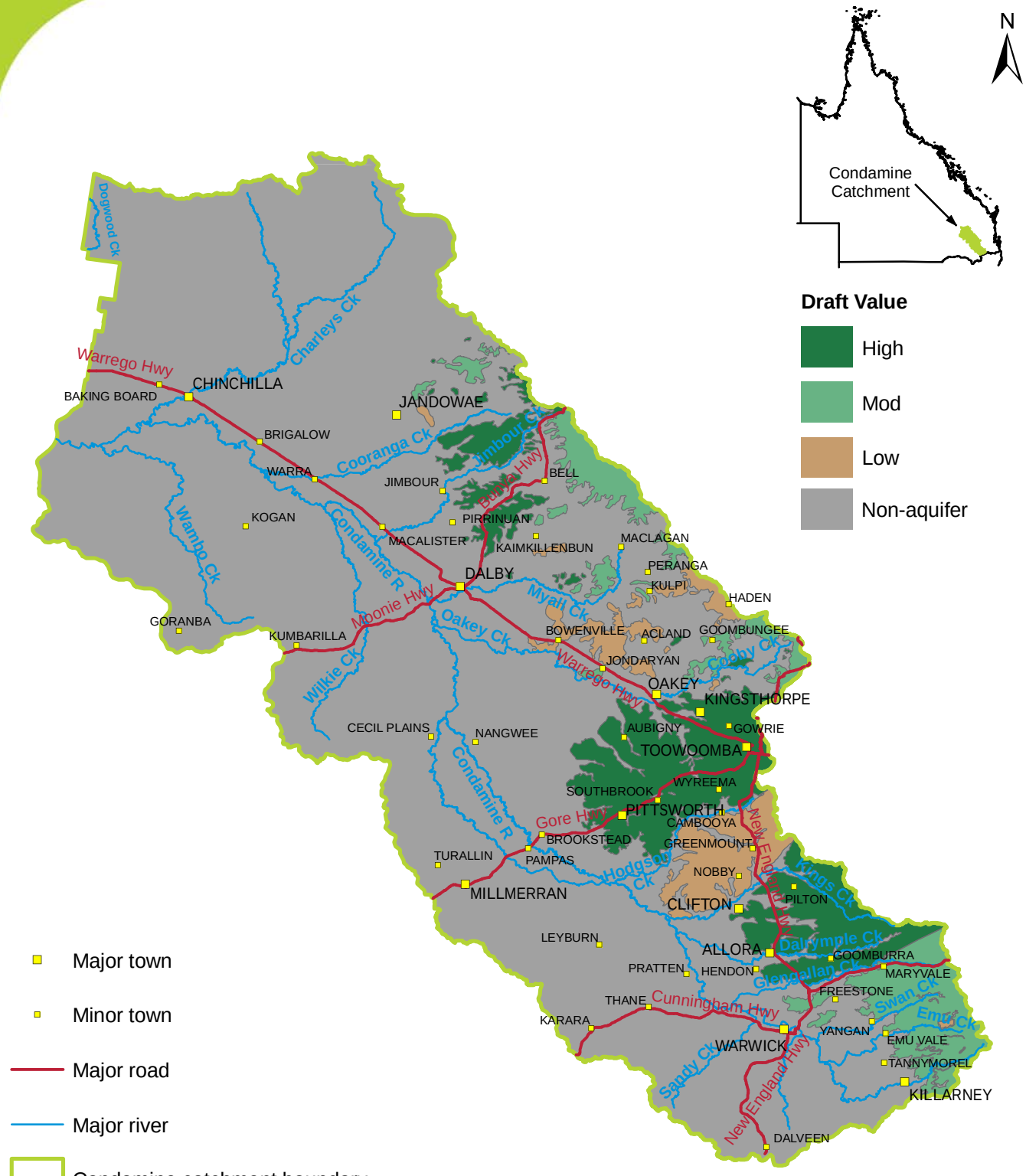
Map 28

Draft Irrigation Value
Environmental Values
Main Range Volcanics
Condamine Catchment

Filename: LR2010-50 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for stock watering and the proportion of grazing area and through community feedback.

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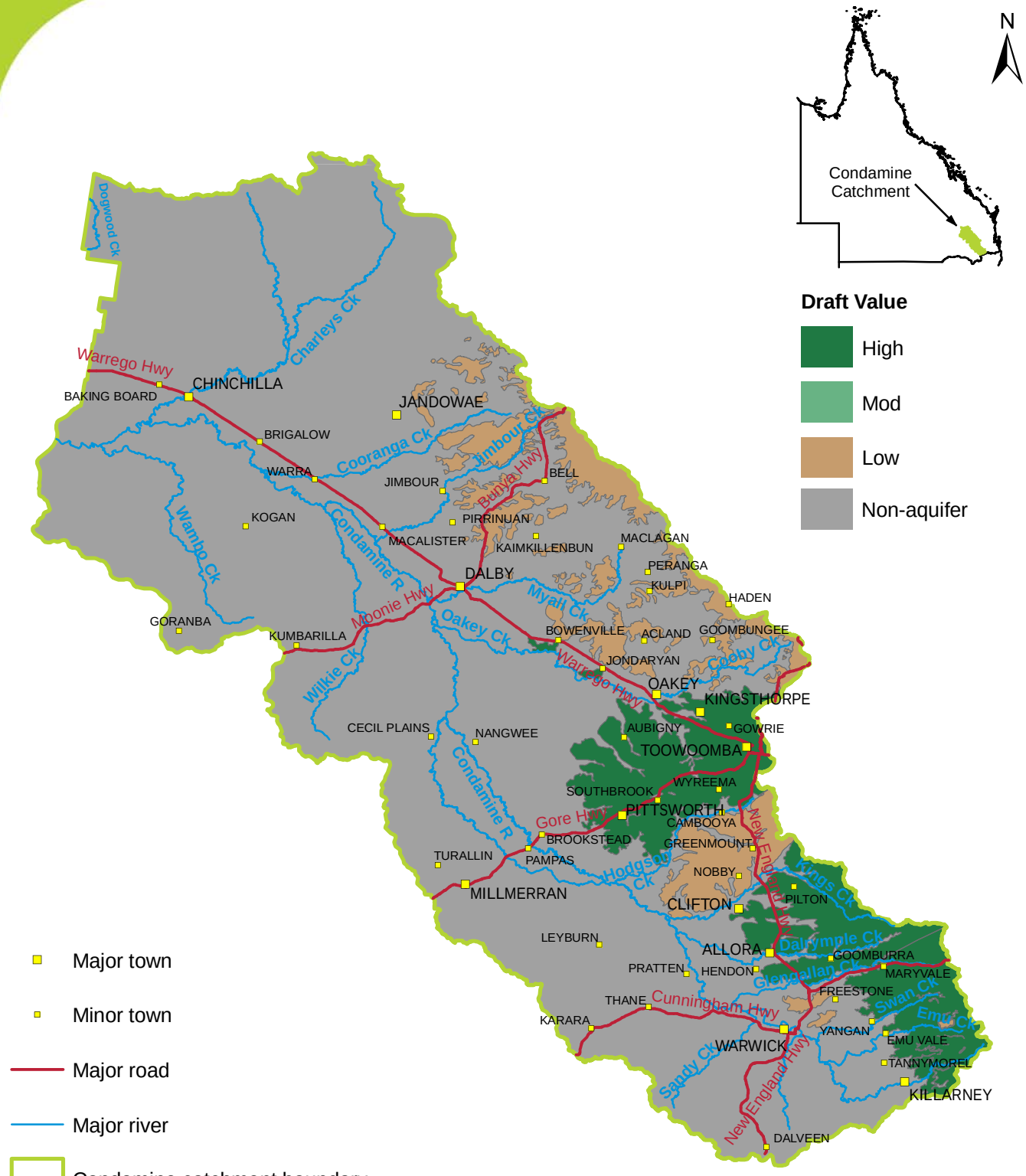
Map 29

Draft Stock Watering Value
Environmental Values
Main Range Volcanics
Condamine Catchment

Filename: LR2010-51 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of known groundwater springs and through community feedback.

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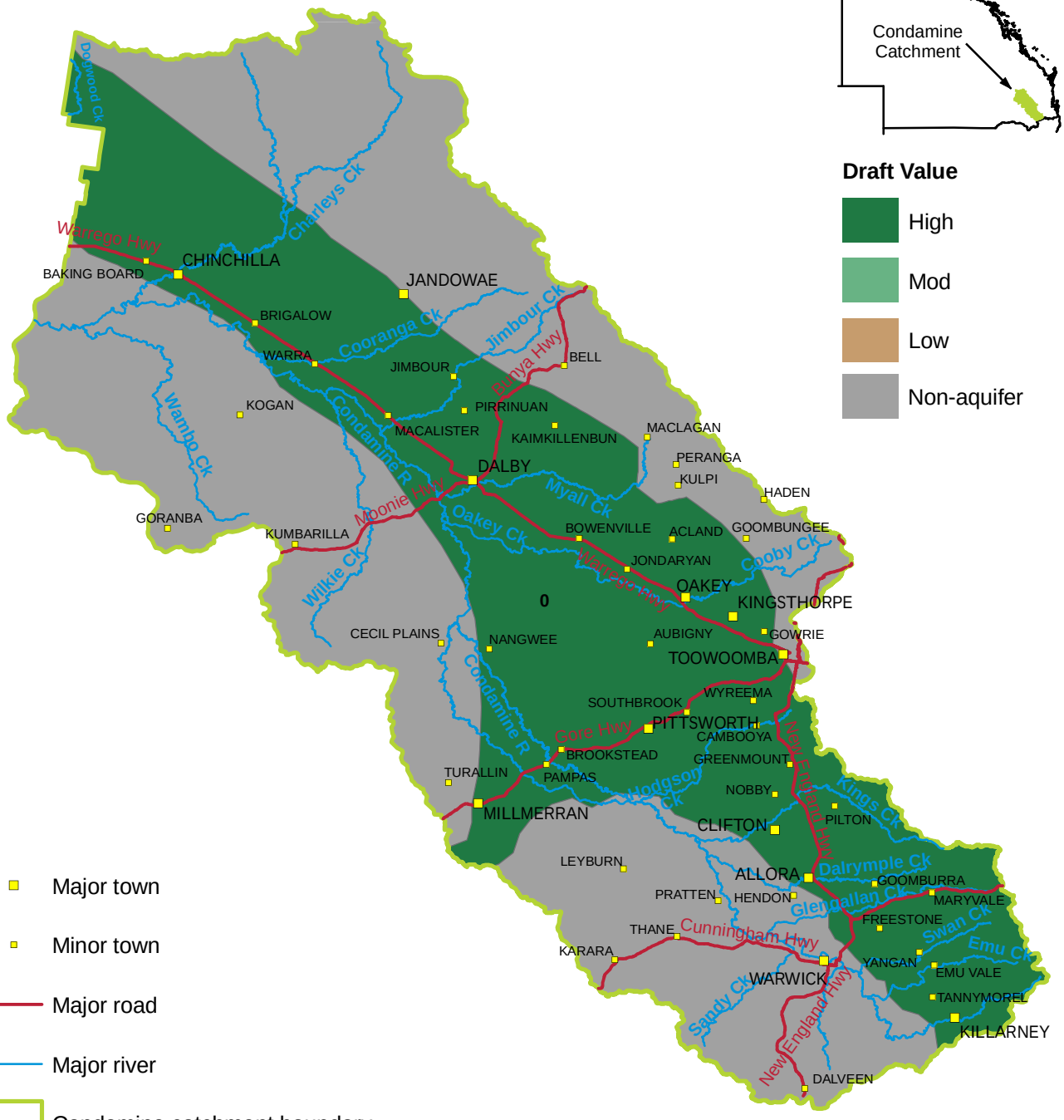
Map 30

Draft Visual Appreciation Value
Environmental Values
Main Range Volcanics
Condamine Catchment

Filename: LR2010-52 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for industrial or commercial uses and through community feedback.

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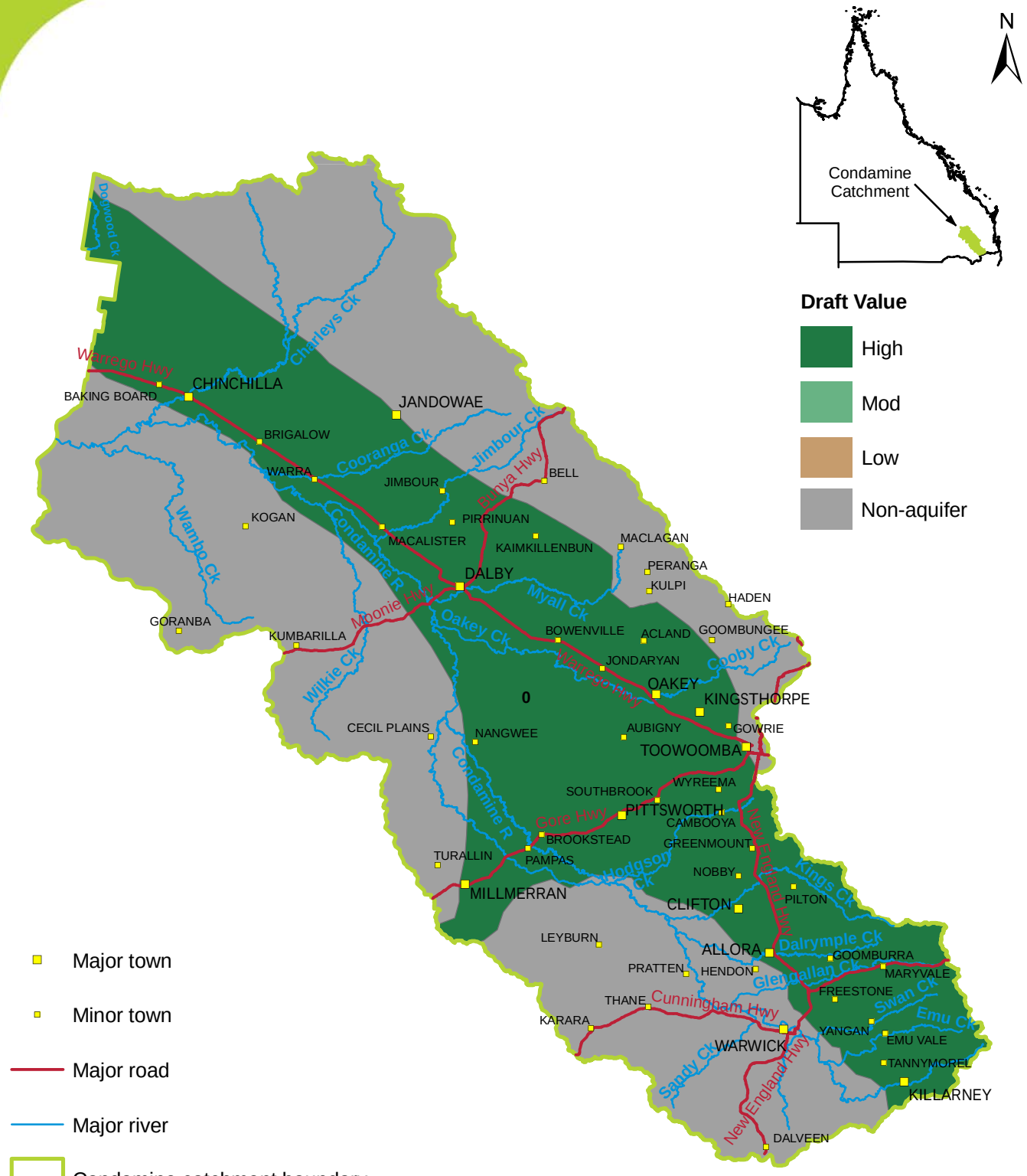
Map 31

Draft Industrial Use Value Environmental Values Walloon Coal Measures Condamine Catchment

Filename: LR2010-53 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for irrigation and through community feedback.

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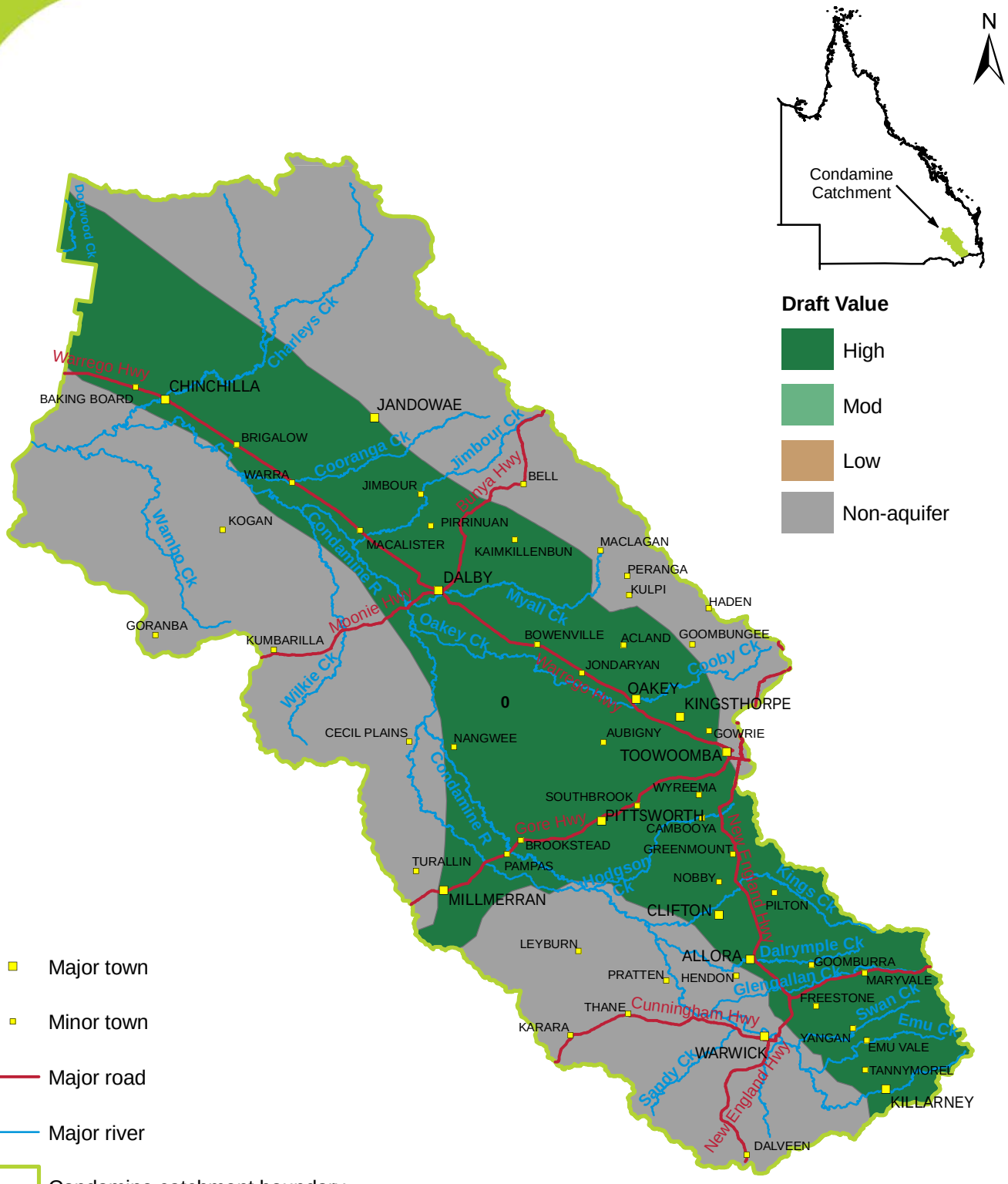
Map 32

Draft Irrigation Value Environmental Values Walloon Coal Measures Condamine Catchment

Filename: LR2010-54 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10



NOTE: This value was determined through the presence/ absence of groundwater extraction licences for intensive livestock and through community feedback.

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Map 33

Draft Farm Supply Value
Environmental Values
Walloon Coal Measures
Condamine Catchment

Filename: LR2010-55 Location: Z:\Mapping\Lucy\Projects Date: 10.11.10

Date: 5 February 2010

To: Laurie Arthur
Commissioner
National Water Commission

CC: David Crombie, National Farmers Federation
Ian Burnett, AgForce
Geoff Penton, QMDB
Dougal Gordon, ALFA
Roderick Gilmour, QGABAC
Ray Brown, Mayor, Western Downs Regional Council

Ground water concerns from Coal Seam Gas Extraction

Paper written by Anne Bridle 5/2/2010

Background

My family and I, operate Talbingo Pastoral Company encompassing 11,740 hectares of mixed farming country south of Dalby and 28,340 hectares of beef backgrounding country at Dirranbandi in Queensland. Talbingo, Dalby is situated on the headwaters of the Moonie River, yet less than 500 metres away from these headwaters, a Coal Seam Gas (CSG) producer holds coal seam gas water in a pond.

We operate a 1,250 head beef cattle feedlot and are licensed to expand to 5,000 head in capacity. The water for our feedlot is provided by bore for which we have an entitlement from the Kumbarilla Bed aquifer under the Water Act 2000. Cattle drinking water in the paddock is provided by 4bores (stock and domestic) and a number of overland flow dams. Over the last 10 years a number of our dams have gone dry due to dry weather. During this time we have, like others in the district, relied heavily on our bores to water stock.

Over the last 15 years, we have spread our climate and production risk across properties at Dalby and Dirranbandi with the later totally reliant on water from Gubbermunda aquifer in the Great Artesian Basin to water an extensive cattle herd. We have fully embraced and completed the GABSCI cap and pipe scheme on the Dirranbandi properties. Our feedlot built in 2006 provides a

contingency plan for drier times and a vertically integrated adjunct to our existing grain and beef production business. In 2008, Talbingo Feedlot was a finalist in the ALFA Feedlot of the Year Competition (<3,000 head capacity). We are licensed to expand our feedlot to 5,000 head capacity which would enable us to turn-off up to 15,000 head of cattle per year. Currently we employ 8 people full time at Talbingo and 2 people full time at Dirranbandi as well as casual contract staff in busy times. We purchase goods and services from local businesses in Dalby, Tara, St George and Bollon and hold major key accounts with business houses in Dalby, St George and Meandarra.

Escalating coal seam gas exploration and more recently production on neighbouring properties and across the Surat Basin is of concern to our business and long term viability due to the possibility of our bore water being unduly affected. We are afraid that coal seam gas extraction will eventually remove water that we are entitled to, taking away our livelihood. Whilst we understand the P&G Act has a make good clause for ground water damage, we are concerned that:

1) *baseline assessments for proving damage have not yet been done;*
2) *groundwater uncertainty as the coal seam gas industry rapidly grows, will stifle our opportunity to expand our feedlot;*
3) *without water supply our infrastructure could be stranded; and ultimately*
4) *CSG Companies, and collectively the CSG industry may not have the economic capacity to make good for other industries such as agriculture if groundwater resources are permanently damaged over time.*

I am aware that other rural businesses both larger and smaller than ours share my concern. I therefore make submission to you as a Commissioner with the National Water Commission to look into the issue of ground water impact from Coal Seam Gas Extraction and its long-term sustainability under current state government policy regimes. In doing so I ask that you consider the P&G Act 2004 and Water Act with respect to the National Water Commission Groundwater position statement. I also ask that in light of the issues raised you provide direction to me and others about how we can protect our long-term viability.

Ground water is the lifeblood of rural businesses and towns in rural and regional communities in Queensland. Climate change towards lower rainfall and higher temperatures will only serve to exacerbate this reliance. Surface and ground water are interlinked and coal seams from which gas is extracted are part of the Great Artesian Basin. Escalation of coal seam gas extraction in Queensland's Surat Basin by its very nature of unregulated and unlimited dewatering, threatens the sustainability of this groundwater system over time.

The highly sought after coal seam methane is held on cleats in the underground coal. The coal seams are not a discreet closed system separate from aquifers above or below them. [Refer: Great Artesian Basin Resource Plan that calls up the Walloon Coal Measures as a distinct management unit within the Great Artesian Basin]. This fact has been missed by many of the CSG companies in their Environmental Impact Studies. CSG companies dewater a coal seam to allow the gas to release from the cleats in the coal. Whilst there are confining layers between the different stratigraphic layers, these confining layers are not watertight and water can migrate between the layers. If dewatering of a system changes the level of the heads significantly, water will migrate laterally and from aquifers above and below. [Refer diagrams Mal Hellmuth's DEEDI Powerpoint presentation, CSG Conference Nov 2009]

Current state government policy dictates CSG companies can withdraw whatever water they need to take, in order to get the gas out. They can use that water for a number of uses within their tenure (determined by definition of "associated activity"). More recently CSG companies are treating the water through reverse osmosis and using it for tree plantations as carbon offsets. Treated water has also been used for cropping irrigation on CSG company owned land. With over 40,000 CSG wells planned to be drilled in the next 3-10 years across the Surat Basin, there are serious concerns for ground water impact.

Ground water concerns from coal seam gas extraction include:

- Contamination from associated water stored at the surface to land and water resources. The sheer volume of 196 Gigalitres of water per year has implications for damage if there is mishap/leakage. Water must be held at some point before use or treatment. As water held in holding ponds naturally evaporates, chemicals, salt and contaminants cumulatively build up. Additionally it has been estimated that up to 10% of associated water cannot be recovered through a reverse osmosis process leaving a huge annual concentrated brine waste to deal with.

- draining contaminated water from coal seams into deeper clean aquifers within the Great Artesian Basin

- the **time lag** between cause (drilling) and effect (draining/contaminants/intermingling of aquifers) The effect could be 10-15 years or longer away

- Contamination of relatively clean ground water could also occur from chemicals used in the fracturing or even drilling process;

- A reduction of recharge retention in areas of gas extraction. Ground water recharge is a natural yet unpredictable event where the seam meets the surface on the inner ranges. Recharge will still occur regardless of the CSG extraction footprint yet how much of that recharged water would make it into the GAB management unit where gas extraction is taking place? Where recharged water migrates to the site of CSG extraction it will most possibly be dewatered. There will also be recharge water from the shallower aquifers which will migrate to the CSG extraction sites and gets dewatered.

- "Time pressure: The "use it or loose it" approach applied to Authority to Prospect licensing exerts a time pressure which is inconsistent with support for long term viability and sustainability to existing industries. Physically transitioning wells from exploration to production can now be done in a matter of days (4) provided a PLA is in place.

Additional factors which may affect impact:

- Grid pattern.
- Fracturing. [Refer Scientific American Article]
- Cumulative affect – CSG & other mining activity
- Uptake of new technologies

Grid pattern Depending on the geology of the ground, wells are spaced on a grid pattern. Typically this has been anywhere from a 500m grid up to a 1200m grid pattern. Whilst the

well grid facilitates a wider dewatering of the coal seam it also resembles over allocation and goes against the very system in place to manage, preserve and harness groundwater.

Fracturing In coal seam gas extraction, where gas is slow to release from the cleats in the coal as the water is removed; hydraulic fracturing may be used to improve gas recovery. Hydraulic fracturing (or "fracking") involves pumping a chemical mixture under high pressure (+3000psi) to blast (fracture) open the coal seam and keep the fracture open. From what I understand the mixture typically comprises water, a "carrying solution" and silica or fine sand. The length, angle and direction of the fracture cannot be fully controlled. The blast at the fracture site in the bore well radiates 360 degrees. [Refer Scientific American Article] As a current example, a CSG well south of Dalby was drilled to a depth of just over 850 metres. This well was recently "fracted" at 9 different depths between 400m and 850m.

Cumulative affect – CSG/other mining/ other activities. The cumulative affect of coal seam gas extraction and wells in the Surat Basin will exacerbate changes in head levels and water quality previously only considered on a local or adjacent bore water user basis. The wide scale dewatering of the Walloon Coal Seam across the Surat Basin will cause water drawdown, quality changes in water and water migration. What will this mean for Great Artesian Basin Water Act bores in other areas of Queensland? How extensive will the area be that is affected by the wide-scale dewatering of the Walloons? Given the energy boom in the Surat Basin, are appropriate separation distances observed between coals seam gas and other forms of mining?

New technologies uptake New technologies are being developed to aid in minimizing associated water being produced with CSG extraction. Whilst I am uncertain of the uptake of these technologies in the Surat Basin I feel strongly that where these technologies reduce and minimise impact they should be encouraged or further, made a condition of the licensing approvals process.

Who ultimately owns the water?

- S19 Water Act 2000 – all rights to the use, flow and control of all water in Qld are vested in the State.

- **Right to ground water take under Water Act** - Entitlement to water under the Water Act 2000 is only possible if water is available in the specified aquifer. In Queensland there are 2,700 artesian and 15,000 sub-artesian bores within the Great Artesian Basin.

- Under the Water Act, there is provision for an un-interrupted water entitlement for stock and domestic use – yet there seems to be no protection for this provision within the P&G Act until the water runs out – if other users have to prove that damage has been done to the water supply, does this mean that every town or property bore has to be assessed at the time of commencement of CSG operations to enable proof that the extraction has damaged the aquifer to the detriment to other water users?

- **Right to water under P&G Act** - P&G Act 2004 - S185 (1), (2) Right to take/ ***unlimited volume*** S185 (3)c.DEEDI modelling (Nov 2009) estimates up to 350,000 ML of associated water will be extracted per year over the next 20-40 years.

- I have been led to believe that it is unlikely that the Govt would ever impose a limit on water taken in the CSG extraction process as the companies need to dewater/de-pressure the coal seam to get the gas out. A limit would restrict their ability to control (reduce) pressures on the gas. Water within a coal seam needs to be constantly removed to maintain or reduce pressure. A limit would restrict CSG production and add years in time for that gas to be removed. Additionally it would follow that an equivalent amount of extra water will be lost from recharge as it occurs. Had CSG Companies ever applied for a Water Act licence to take water in the estimated quantities and densities planned for the next 5-20 years they would ***NEVER*** have got entitlement. Such take could not be sustained.

- **Monitoring and recording – P&G Act.** Current legislation prescribing monitoring and reporting of underground water impact by CSG companies was not met by any CSG company up until July 2009. Many CSG companies are yet to lodge these reports despite producing CSG for almost 10 years. The Queensland Government had not been enforcing compliance with the P&G Act. I am led to believe that some CSG companies establishing water head levels now are doing so at today's level not the original level off their drill log when they commenced production. What damage/draw down has already been done?

- **"Make Good" provision**. The P& G Act 2004 contains a "make good provision" which is intended to balance the right of the petroleum tenure holder to take underground water as part of its authorised activities against any adverse impacts upon existing Water Act bores by the taking of the water. The "make good" clause allows for either financial compensation for loss of water, water supply from an alternative source or deepening of existing water bores to access deeper water. However, to utilise the make good provision for such damage, damage must be proven and requires, baseline assessment prior to CSG activity commencing as well as proper and regular monitoring ,must have been done. I have been led to believe that baseline reporting has not been done.

- The Act was written at a time when CSG industry was in its infancy and there was not a significant concentration of petroleum gas extraction activity. Water from the Great Artesian Basin system is a finite resource fully allocated within guidelines for its sustainability. CSG producers do not have spare titles to Great Artesian Basin water to pass onto affected stakeholders in the event of significant damage. Transfer of title is possible under the Great Artesian Basin Relocation Scheme but this requires a willing buyer and a willing seller.

- In the event that cumulative CSG activity significantly damages underground water aquifers, from where will the alternative water come? How will CSG producers be able to compensate affected stakeholders for loss of their business as a result to damage to Water Act bores? It has been suggested that CSG producers could provide treated CSG water to affected Water Act bore users. However, how long will the treated CSG water last? 10 – 20 years? Again, in the event of adverse impact, from where, will the water come long after CSG producers have left and treated CSG water is no longer available? For how long does the obligation on petroleum tenure holders "to make good" last?

- **Associated water & associated activity.** The water taken by the tenure holder is known as associated water (which is a regulated /hazardous waste) and it can only be used by the tenure holder for another authorised activity for the tenure. To use associated water for another purpose the tenure holder must obtain a water licence and obtain approval from the EPA in most cases to beneficially use that water. Certain other approvals may also need to be obtained such a development approval. P&G Act S188 &

189; Water Act S19. Obtain water licence Ch2 Part 6. Section 66F Environmental Protection (Waste Management) Regulation 2000 – beneficial use.

- A CSG company that dewaters a coal seam and treats the water through a RO plant can apply to obtain a water licence for the beneficial use of that water. There have been suggestions that CSG companies are looking to sell treated water for $5000-$7,000/ML. Hypothetically, assume no damage has been done as yet to existing water entitlements and the CSG company on-sells that water for beneficial use. Assume also that over time damage does occur, draw down is affected and water entitlements are taken out through unavailable water. Theoretically the CSG has sold a water entitlement it never "owned" to the highest bidder. The system is again over allocating a finite resource. Time lag between cause and effect removes priority group consideration for water if damage is eventually done yet the associated water has already been treated and sold off. Additionally, I understand water for "beneficial use" requires **no** compliance for sodicity (sodium absorption ratio) – this has implications for soil structure over time.

- The placement of pipelines to transport treated CSG water under the P&G Act rather than the Water Act, means CSG companies can just put treated water pipelines through any landowners property in the future. Under the Water Act they would have had to have landholder permission in the form of an easement or a lease. Also under the Water Act they would have to get Water Licences hence making them have to contact priority groups and all other relevant regulations for water as per the Water Act 2000. [Refer O'Connor & O'Connor Vs Arrow (2009) Supreme Court of Queensland – Orders and Judgement]

- Who monitors the dams built on CSG owned land (seepage) and who regulates the associated water that finds it way to this land? Are there any regulations or is this matter self-regulated? CSG companies are buying up properties and using treated RO water for irrigation. (Once treated the water is 200ppm Sodium, they then add "associated water" with the fresh treated water to increase the Sodium levels back to 1000ppm EPA). The water is then used to irrigate soils already high in salinity.

- Rural and regional business operate on longer sustainability time frames – there needs to be consideration to the social, economic and natural resource legacy that will be left

long after CSG harvesting of 20-30years . Has the social impact from the potential loss of existing industries and ultimately community as a result of coal seam gas extraction been considered? Some businesses and towns simply cannot exist without bore water. Does the CSG industry have the economical capacity to make good in the event of cumulative far reaching damage to groundwater?

SUMMARY

Coal seam gas extraction in the Surat Basin, Queensland presents long-term ground water sustainability concerns under current state government policy regimes. The sheer volume of water predicted to be removed from the Great Artesian Basin over the next 20-40 years should be sending shock waves to bore water users, small business, towns, communities and the Queensland people. The P&G Act 2004 giving CSG companies unlimited water take in the process of gas extraction does not comply with the National Water Initiative where all governments of Australia are committed to a 'whole of water cycle' approach.

A Risk to Groundwater from Coal Seam Gas Extraction in the Surat Basin

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Keywords: coal seam gas; Surat Basin; agriculture

Abstract

The potential exists for land use conflict to arise between coal seam gas mining and traditional agriculture in the Surat Basin in Southern Queensland. Farming and grazing enterprises, businesses and towns in the region are largely dependent on the underground aquifers for their water supply. The process of extracting the gas from the coal seam results in the withdrawal of large quantities of water from the aquifers which underlie the basin and form part of the Great Artesian Basin water resource. Under State Government legislation the Coal Seam Gas Companies are allowed unlimited take of underground water while extraction of water for other users is controlled by the State Government. There is concern that due to connectivity between the coal seam and the aquifers that the dewatering during the gas extraction process is unsustainable. The risk of connectivity may be increased through the fracturing process used to enhance the release of the gas from the coal seam. It appears that the legislation governing the Coal Seam Gas industry does not protect the underground aquifers and that the Queensland Government has not followed the Precautionary Principle for sustainable development of this industry.

Introduction

It is acknowledged that the mining, petroleum and gas industries are underpinning the Australian economy at the present time through their contribution to export income; however agriculture is also a major contributor to the national economy accounting for approximately

one quarter of all export earnings, depending on the seasons and international markets (Encyclopedia of the Nations, 2010). In some parts of the rangelands of Australia there is the potential for conflict between the two industries over land use and sustainability, due in part to ineffective or defective regulation and legislation leading to poor governance (Schand and Darbas, 2008).

This paper focuses on the effect on ground water from the extraction of Coal Seam Gas in the Surat Basin of Southern Queensland. This is a region where the State Government and irrigators extracting water from the Condamine Alluvium have agreed that extraction at the rate of 47 gigalitres a year is unsustainable and it is recommended that the level of extraction be reduced to 30 gigalitres per year (Barnett and Muller, 2008). At the same time the Coal Seam Gas industry has been given the right under State legislation to unlimited take of underground water during the gas extraction process (Petroleum and Gas [Production and Safety] Act, 2004).

Our Water and Gas Resources

Ground water is the lifeblood of businesses and towns in rural and regional Queensland and predicted climate change towards lower rainfall and higher temperatures (Allen Consulting Group, 2005) will exacerbate this reliance. The Surat Basin is one of three major depressions which comprise the Great Artesian Basin (Department of Natural Resources and Water, 2006) and the Walloon Coal Measures, from which coal seam gas is extracted, are part of this system (Hellmuth, 2008; Great Artesian Basin Resource Operations Plan, 2007). The Springbok and Hutton aquifers lie above and below the coal seam and, in the Eastern part of the basin, the Condamine alluvium aquifer, though not part of the Great Artesian Basin, lies directly above the coal seam or the Springbok aquifer and is the highest allocated groundwater source in the State (Hellmuth, 2008). Escalation of coal seam gas extraction in the Great Artesian Basin by its very nature of unregulated and unlimited dewatering threatens the sustainability of this system over time.

Coal seam methane is held on cleats in underground coal seams and the current extraction method used by Coal Seam Gas companies is to de-pressure the coal seam, by dewatering, to

allow the gas to be released from the cleats in the coal. The coal seams are not discreet systems separate from aquifers above or below them, and while there are confining layers between different stratigraphic layers, these confining layers are not watertight and water can migrate between the layers (Figure 1). The dewatering of the coal seams may establish connectivity through the disruption of the hydraulic conditions that maintain the dynamic flow equilibrium in the aquifers (Hellmuth, 2008). Settling of the individual sedimentary formations in the Surat Basin of the Great Artesian Basin has resulted in numerous faults, folds and fractures in the water containing porous sandstone (Hillier and Foster, 2002). If dewatering of a system changes the level of the heads significantly, water will migrate laterally and from aquifers above and below (Figure 1) and in areas where there is fracturing or faulting the risk of this process will be exacerbated (Hellmuth, 2008).

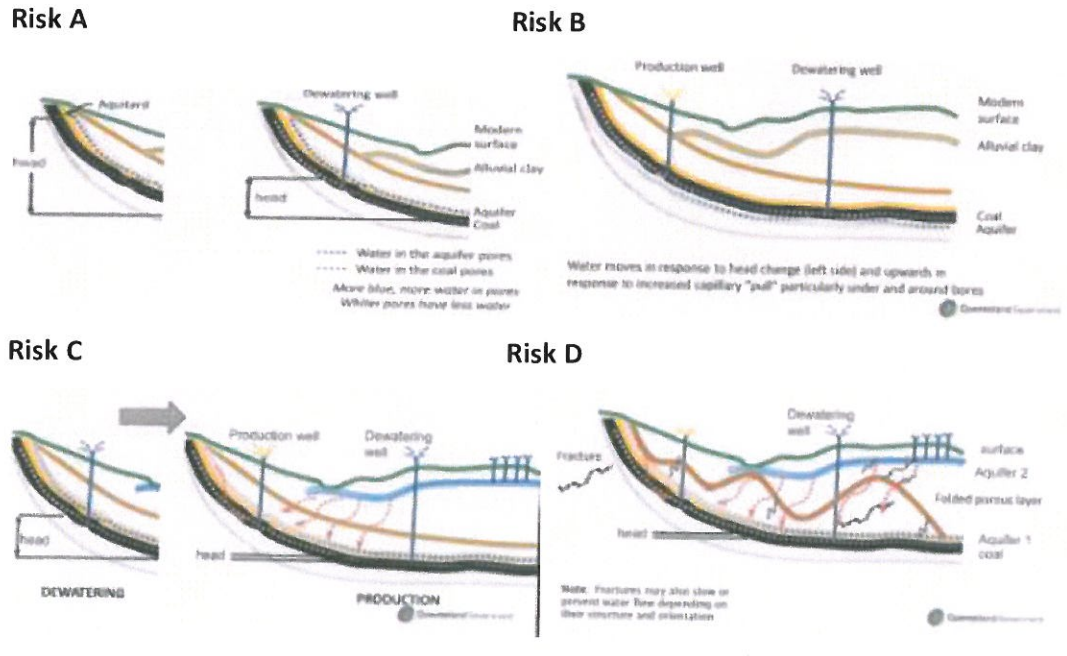
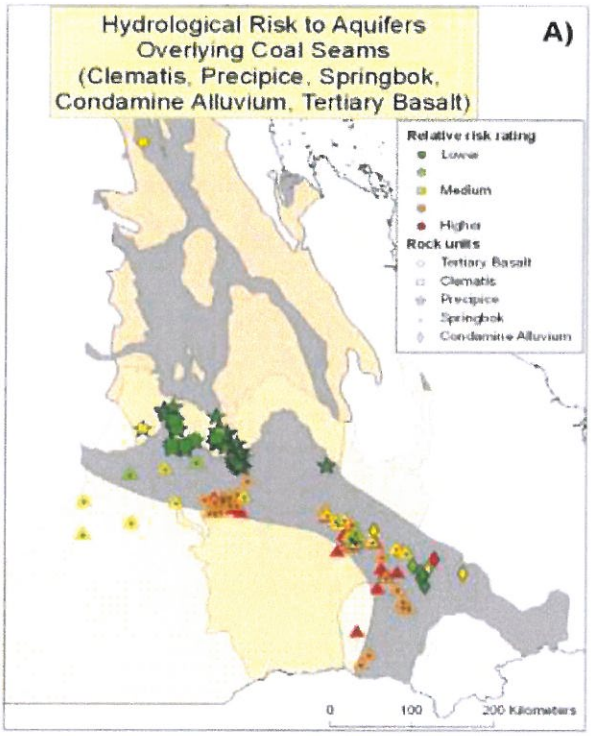


Figure 1. Risk A: water movement through the aquitard from aquifer into the coal seam in response to a drop in head; Risk B: Water movement from aquifer below coal into coal responding to dewatering; Risk C: Gas production and dewatering reduce head and trigger possible second (and subsequent) aquifer interactions; Risk D: Fracturing and folding increase the chance that water movement from distant aquifers is triggered). Source: Department of Employment, Economic Development and Innovation, 2010.

The hypothesised risks to the overlying (Figure 2 A) and underlying aquifers (Figure 2 B) in the Surat Basin indicae that the highest risks are to the Condamine aluvium aquifer, the Springbok aquifer and the Hutton aquifer, the latter is an aquifer of the Great Artesian Basin (Hellmuth, 2008).



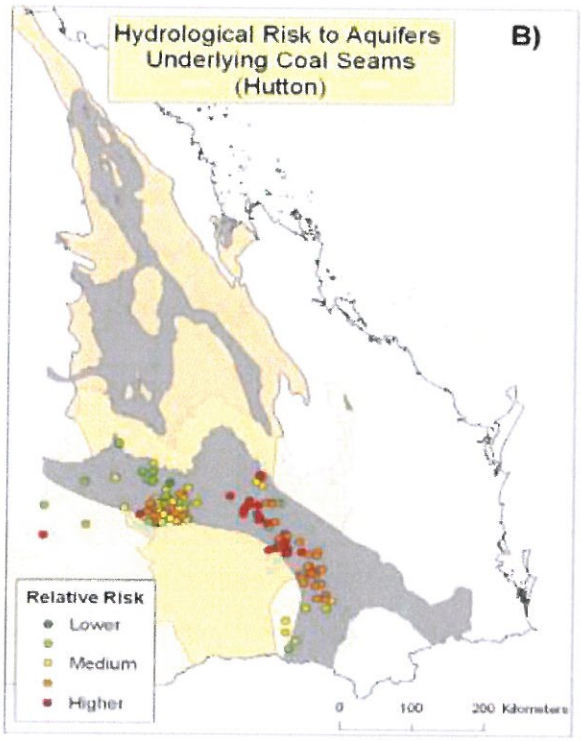


Figure 2 – Relative risk to aquifers A) overlaying coal seams and B) underlying coal seams in the Bowen and Surat Basins Source: Hellmuth, 2008

The problem and Concerns

In coal seam gas extraction, where gas is slow to release from the cleats in the coal as the water is removed, hydraulic fracturing may be used to improve gas recovery. Hydraulic fracturing involves pumping a chemical mixture under high pressure (+3000psi) to blast (fracture) open the coal seam and keep the fracture open. It is understood a typical mixture comprises water, a "carrying solution" and silica or fine sand. The length, angle and direction of the fracture cannot be fully controlled and the blast at the fracture site in the bore can radiate 360 degrees. (American Petroleum Institute, 2009).

In Queensland, under the Water Act, 2000 Section 19, all rights to the use, flow and control of water are vested in the State. Under the Queensland Petroleum and Gas [Production and Safety] Act (2004) Section 185, Coal Seam Gas companies have the right to take *unlimited*

volume of water during extraction. It is considered unlikely that the Queensland Government would impose a limit on water taken in the extraction process as the process used in the Surat Basin requires the seam to be de-watered and de-pressured in order to extract the gas. Modelling by the Department of Employment, Economic Development and Innovation in November, 2009 estimates a mid-range of 196 gigalitres of associated water per annum will be released by Coal Seam Gas extraction, which is between 120-350 gigalitres per annum of water removed from the aquifers over the next 20-40 years (DEEDI, 2010).

Entitlement to water under the Water Act (2000) is only possible if water is available in the specified aquifer, there is also provision for an un-interrupted water entitlement for stock and domestic use. However the Petroleum and Gas [Production and Safety] Act (2004) does not appear to protect this provision though it does contain a "make good" provision which is intended to balance the right of the petroleum tenure holder to take unlimited underground water as part of its authorised activities against any adverse impacts upon existing bores.

However, to utilise the "make good" provision, water drawdown against specified trigger levels must be proven and requires baseline assessment prior to Coal Seam Gas activity commencing as well as proper and regular monitoring. Monitoring and reporting of underground water impact by Coal Seam Gas Companies required under the Petroleum and Gas Act (2004) had only been met by one company up until June, 2009 (Response to Question on Notice 641, Queensland Parliament, 18th June, 2009). Further, there is no "make good" provision for water supply where water quality is unduly affected, the "make good" provision only covers impact to water quantity or pressure (Petroleum and Gas [Production and Safety] Act, 2004).

It is not immediately apparent just how the "make good" provision in the Petroleum and Gas (Production and Safety) Act (2004) can ensure an alternative water source for rural and regional communities in the event of their ground water being unduly affected by coal seam gas extraction. There is a moratorium on accessing new water from overland flow in Queensland (Condamine Balonne Resource Operation Plan, 2010); there are no new water entitlements available from the Great Artesian Basin (Great Artesian Basin Resource Operation Plan, 2007);

Coal Seam Gas companies do not own "spare" Great Artesian Basin water licence entitlements to pass on to affected stakeholders (Great Artesian Basin Database search through Department of Environment and Resource Management, June 2010) and climate change predicts lower rainfall and higher temperatures (Allen Consulting Group, 2005). In some regions of the Surat Basin groundwater impact caused by Coal Seam Gas companies is just a matter of time (Hellmuth, 2008).

In a scoping study looking at mining and energy driven economic development in the Surat Basin, Schand and Darbas (2008) suggested that the guiding principles for sustainable development should be using the resource prudently and implementing the "Precautionary Principle". There appears to have been little "Precaution" evident in the development of the Coal Seam Gas industry to date and the potential loss of existing industries and communities could place an enormous social and financial burden on the people of Queensland. Damage to, or depletion of, our precious aquifers and the iconic Great Artesian Basin would place an indelible stain on our environmental record.

Conclusions

It is more than four years since landholders in the Surat Basin first raised concerns regarding the sustainability of Coal Seam Gas extraction in relation to underground water in their region. This extraction presents long-term ground water sustainability concerns under current State Government policy. The sheer volume of water predicted to be removed from the regions aquifers over the next 20-30 years should be sending shock waves to bore water users, small businesses, towns, communities and the Queensland people. It is difficult to reconcile the actions of a Government which professes to be sensitive to environmental and sustainability issues when those actions strongly favour development of an industry without thought to the environmental consequences and an apparent disregard to the "Precautionary Principle".

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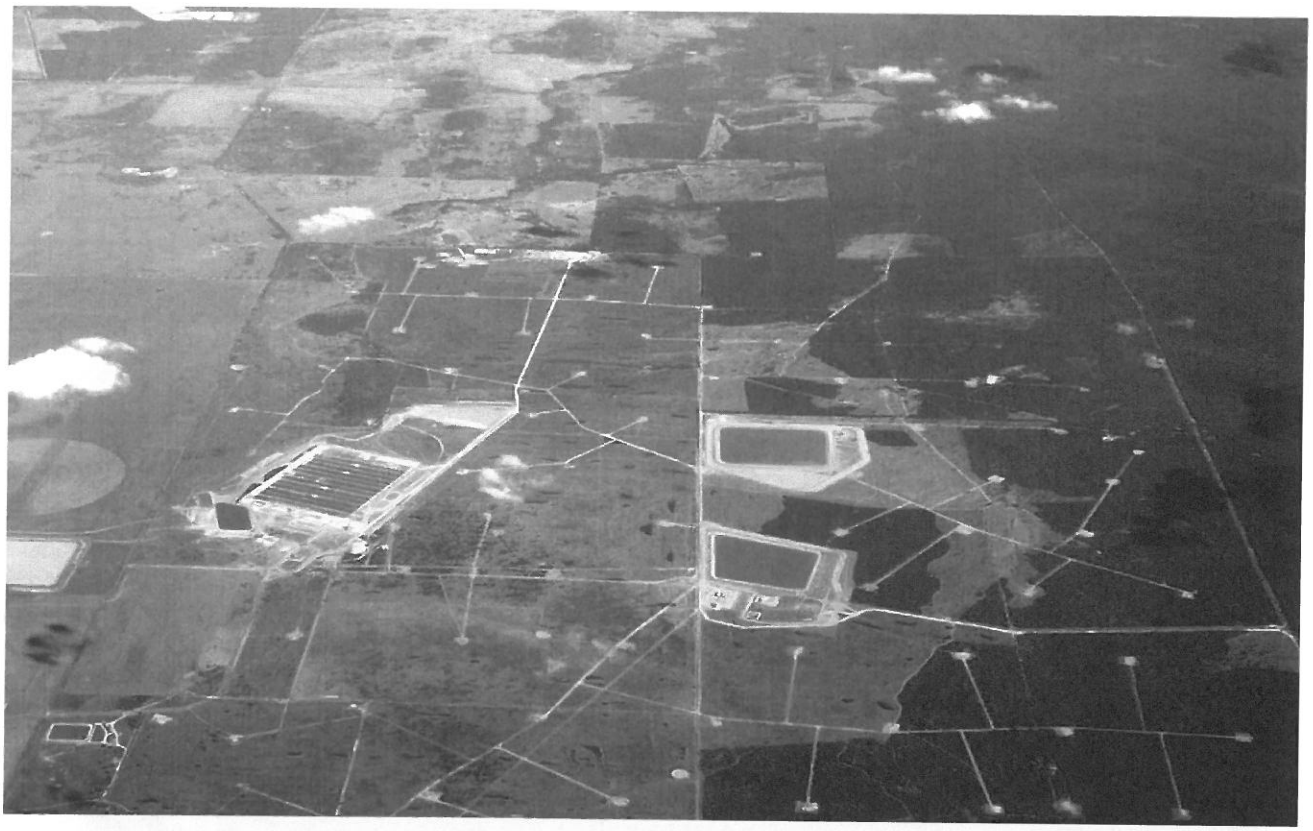
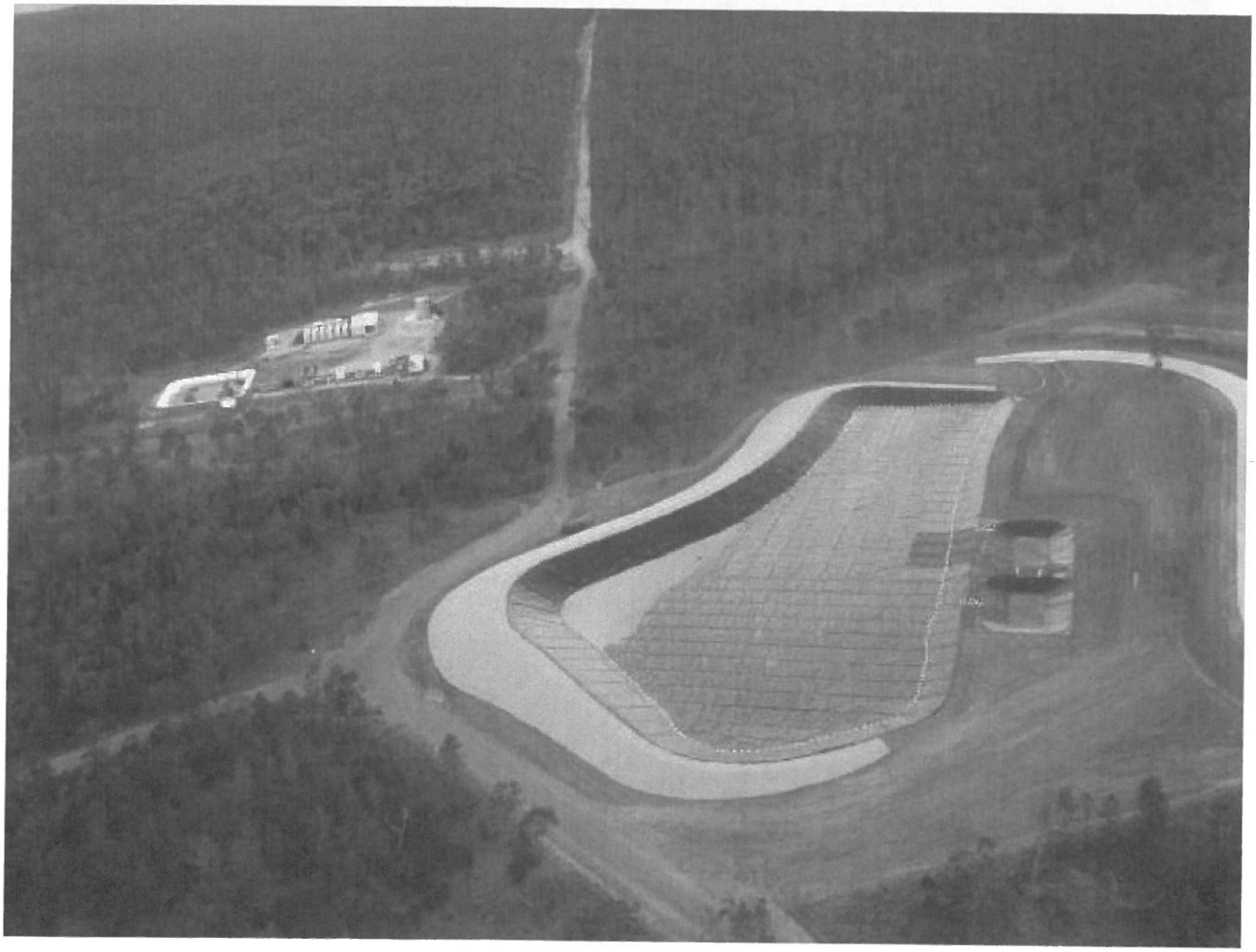
Typical Queensland CSG Gasfield and CSG Gasfield Infrastructure





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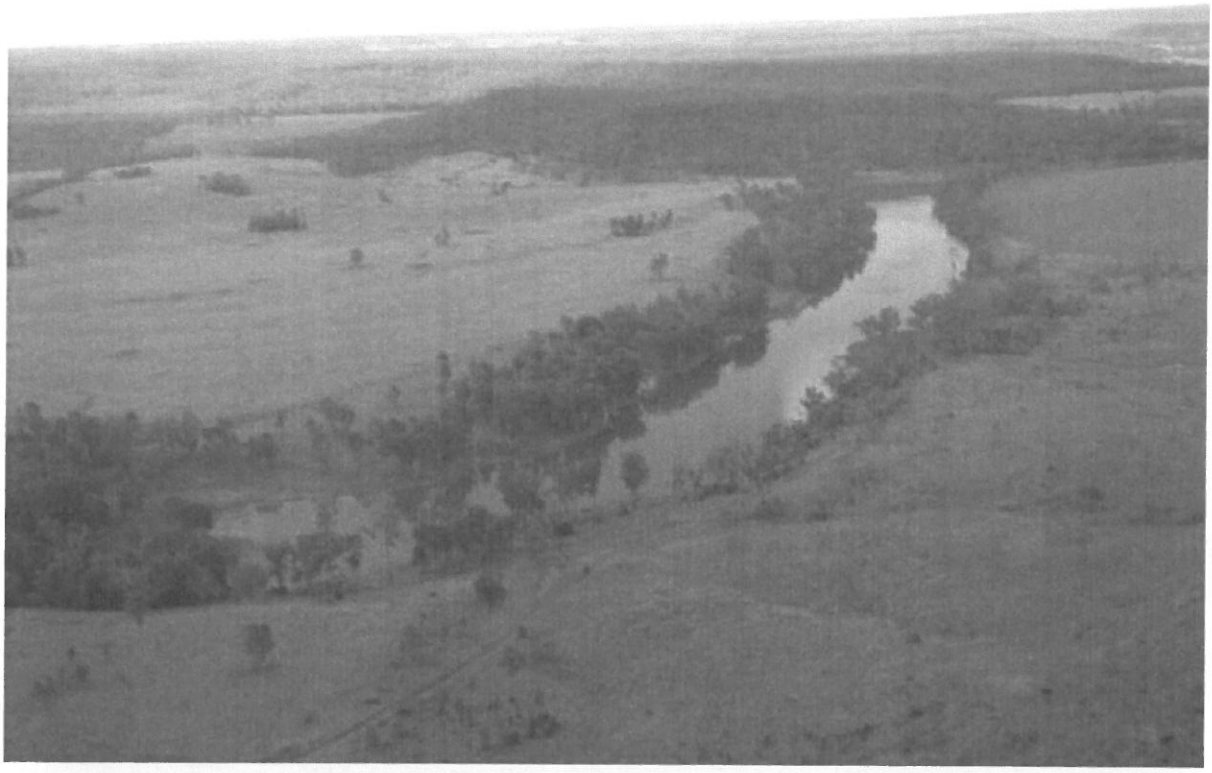

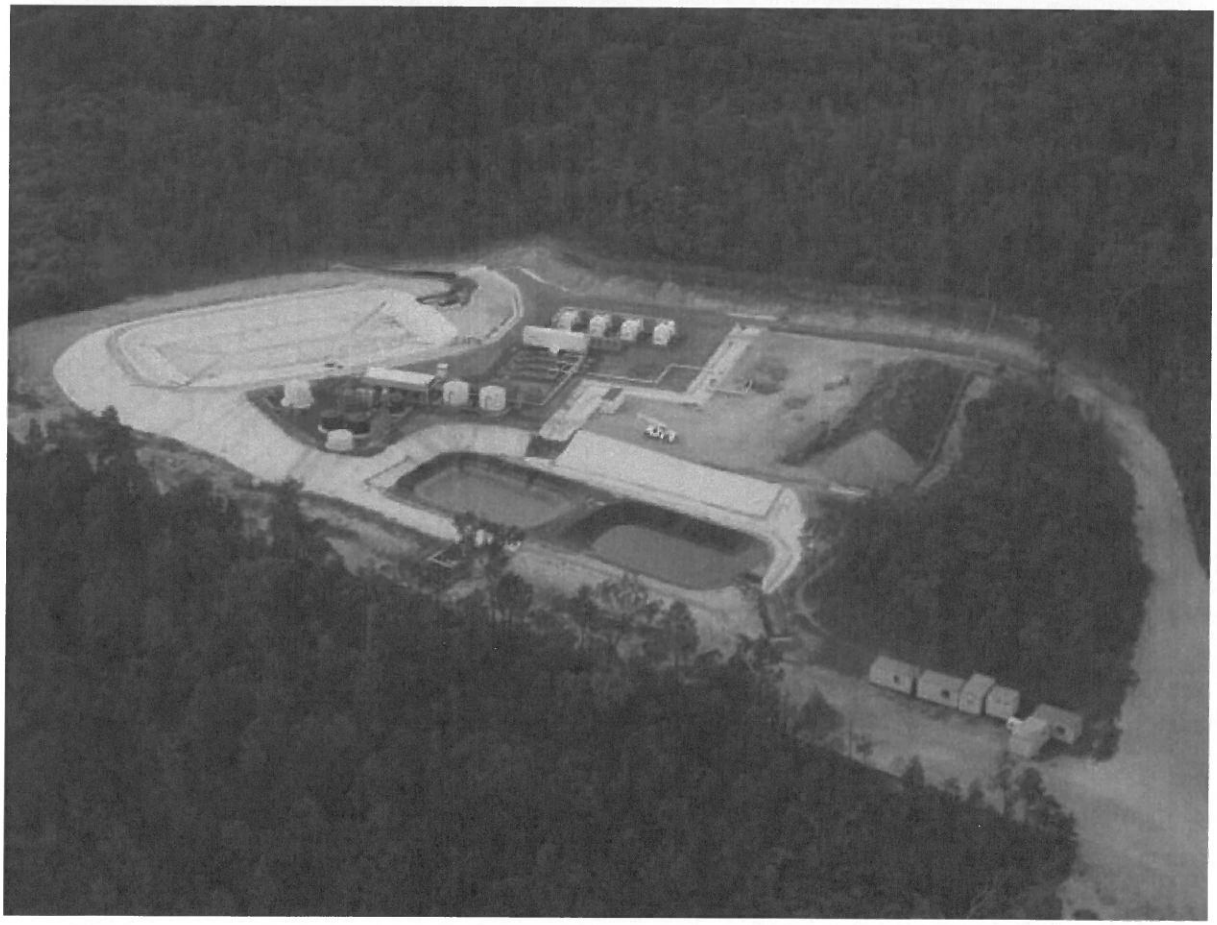

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