
Resource / Mining Framework and its Application to the Greater Macarthur Land Release Investigation



12 June 2015



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Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AEP	Annual Exceedance Probability
ALUM	Australian Land Use and Management (classification)
APFGS	A Plan for Growing Sydney
BSOP	Bulli Seam Operations Project
CCA	Comprehensive Coastal Assessment
DP&E	NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
EEC	Endangered Ecological Communities
EMAI	Elizabeth Macarthur Agricultural Institute
EPA	Environment Protection Authority
FSPUD	Food Sensitive Planning and Urban Design
FTE	Full Time Equivalent
GMLRI	Greater Macarthur Land Release Investigation
GMRA	Greater Macarthur Rural Area
GVP	Gross Value of Production
ICHPL	Illawarra Coal Holdings Pty Ltd
IMC	International Mining Consultants
LEP	Local Environmental Plan
LGA	Local Government Area
LLS	Local Land Services
MCA	Multi-Criteria Analysis
MNES	Matters of National Environmental Significance
MOP	Mining Operations Plan
MRA	Metropolitan Rural Area
MRF	Materials Recovery Facility
MSB	Mine Subsidence Board
NPV	Net Present Value
OEH	NSW Office of Environment and Heritage
R&D	Research and Development
RD&E	Research, Development and Extension
RDA	Regional Development Australia
ROM	Run of Mine (coal)
SASA	Sydney Agriculture Strategic Approaches (working group)
SILEP LZN	Standard Instrument LEP Land Zoning
SPUN	Sydney Peri-Urban Network
SREP	Sydney Regional Environmental Plans
SSD	Sydney Statistical Division
UTS	University of Technology Sydney
WCMG	Waste Coal Mine Gas

Executive Summary

Consistent with 'A Plan for Growing Sydney' Actions 2.4.2 and 4.1.2 a strategic framework for the assessment of social, economic and environmental values in the Metropolitan Rural Area was required by the NSW Department of Planning and Environment. This report describes the framework and applies it to the 'urban capable' footprint defined by the NSW Department of Planning and Environment and master planners Urbis.

The framework addresses a range of assets and values including:

- Biodiversity
- Water quality
- Air quality
- Agriculture
- Mining/natural resources
- Tourism and recreation
- Fire and flood constraints
- Other special uses (e.g. military lands)
- Aboriginal archaeology and European heritage
- Rural towns, villages and rural residential
- Waste management

1 Introduction

1.1 Resource / Mining Framework Purpose

Consistent with 'A Plan for Growing Sydney' (APFGS) Actions 2.4.2 and 4.1.2 a strategic framework for the assessment of social, economic and environmental values in the Metropolitan Rural Area (MRA) was required by the NSW Department of Planning and Environment (DP&E). The framework was applied to the Greater Macarthur Land Release Investigation (GMLRI).

1.2 Greater Macarthur Land Release Investigation

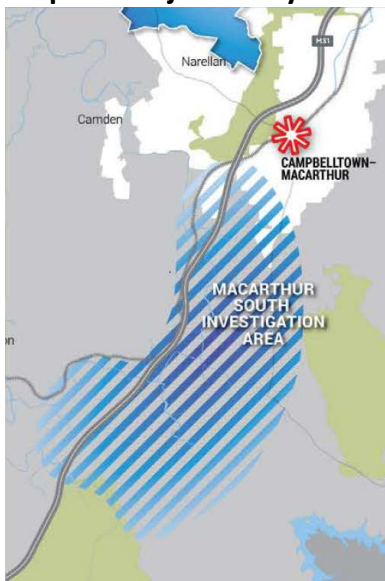
The DP&E is working with Campbelltown and Wollondilly Councils, Transport for NSW, and other agencies to guide the GMLRI.

This investigation is examining the possibility of developing new urban communities in the Greater Macarthur area and if so, when. Firstly, the Government will be guided by its statutory responsibility to assess how new urban areas would impact the natural environment, agricultural and mining activities. A key consideration will be the likely positive and negative impacts for existing communities in the area.

The investigations will then focus on how any new potential communities would access jobs, services and amenities, including what the costs of infrastructure would be and how it would be funded.

Government recognises that there are a number of proposals and private sector interest in the Greater Macarthur area which is why it will take an efficient, coordinated approach to its investigations. This study will therefore be mindful of existing private proposals for housing and employment opportunities in the Appin & West Appin, Wilton Junction, South Campbelltown, Menangle Park, Mount Gilead and Menangle areas. Study area is shown in Map 1.1.

Map 1.1 Project Study Area



Source: 'A Plan for Growing Sydney'
Figure 2 page 13

1.3 Project Overview and Approach

A strategic framework consistent with 'A Plan for Growing Sydney' Actions 2.4.2 and 4.1.2 was developed to assist with decision making by establishing information and criteria to help decision makers to balance environmental, economic and social values and consider how different rural activities (e.g. agriculture, mining, tourism) can be accommodated and sequenced where a new Growth Centre has been identified.

Delivery of the project included review of relevant literature and maps, current policy, site orientation with DP&E 25 February 2015 and consultation with stakeholders including representatives from the Wollondilly and Campbelltown Councils (17 March 2015 field visit), NSW Department of Trade and Investment – Division of Resources and Energy, NSW Department of Primary Industries (DPI), the Environment Protection Authority (EPA), the Waste Asset Management Corporation, Destination NSW and the Sydney Agriculture Strategic Approaches (SASA) Working Group (9 March 2015). The SASA Working Group is chaired by NSW DPI and includes representatives from DP&E, local government, Local Land Services (LLS), academia and Regional Development Australia.

Literature review and consultation resulted in the identification of a range of assets and values of the MRA including:

- Biodiversity
- Water quality
- Air quality
- Agriculture
- Mining/natural resources
- Tourism and recreation
- Other values – fire and flood constraints, other special uses (e.g. military lands), Aboriginal archaeology, rural towns and villages
- Waste management

The strategic framework was developed using approaches suggested in the literature including NSW Planning's Comprehensive Coastal Assessment (DP&E 2006). The resultant framework was populated with GMLRI data and draft results were provided to various DP&E and Master Planner convened workshops (18 February, 19 March, 27 April, etc.). Study reporting included an assessment of how the framework could be applied to other parts of the MRA and preparation of draft and final project reports.

1.4 Developing a Strategic Framework for the MRA

Introduction

The strategic framework for the MRA aims to provide information to assist decision makers in balancing the broad range of environmental, economic and social assets and to consider how different rural activities can be accommodated and sequenced.

Framework Objective

Conceptually, the objective of land use planning is to maximise the net benefits of present and future generations from a combination of land uses which benefit the wider community, now or in the future.

To quote Action 4.1.2 from '*A Plan for Growing Sydney*': 'The strategic framework will balance the MRA's significant conservation, economic and social values. The framework will assist decision makers by establishing criteria to:

- Minimise the adverse economic impacts on existing primary industry and productive agriculture
- Consider critical natural resource constraints
- Provide adequate public open space and recreational activities and avoid creating unsustainable pressure on existing Crown Land areas and State Forests
- Consider natural hazards, such as the need to evacuate people from flood/bushfire prone areas; how flood-prone areas will be avoided and not increasing flood risks in new housing areas (through early planning for stormwater management)
- Consider and plan to protect significant natural resources including water quality, riparian and aquatic habitats and marine estates.

In the longer term, the development of demand and supply data sets for agriculture and resource extraction industries will be explored.

The Government will work with councils to develop a detailed planning framework for the area that:

- Protects the Greater Blue Mountains World Heritage Area and other natural areas across the Metropolitan Rural Area, while fostering opportunities for international tourism, including a review of management and monitoring of impacts and cumulative effects of surrounding land uses on the World Heritage environmental values
- Identifies and protects the productive mineral, energy and construction material needs and provides appropriate buffers
- Protects productive agricultural land to keep fresh food available locally by planning for the infrastructure and land use needs of agricultural activity and providing appropriate buffers between different land uses to minimise conflicts
- Protects the Sydney drinking water catchment by requiring new development in the catchment to have a neutral or beneficial effect on water quality (consistent with Government policy)
- Manages the risk from natural hazards, particularly flooding in the Hawkesbury-Nepean Valley and bushfires, by mapping where geophysical factors impose constraints on economic activity and urban development
- Considers how all these activities can be best accommodated, including the sequencing of various activities, such as mining and urban development'.

This framework requires consideration of the broad range of environmental, economic and social values associated with the rural lands in particular its role and relationship to the greater metropolitan area of Sydney.

Overarching Principles

Overarching principles for land use allocation include that:

- All land uses are associated with values to society.
- Some of these values are mutually exclusive while others can be complementary.
- The objective for land use allocation may be achieved via allocation of land to multiple land uses simultaneously, sequential land uses or a single land use.
- Land use planning may involve trade-offs between values that are mutually exclusive. Where one land use displaces another, values from the displaced land use will be lost temporarily or permanently.

Consideration of Absolute Constraints

There are a number of constraints to the use of land in the MRA that for the purpose of planning for rural lands and other uses can be considered to be absolute where a value has been established through government policy. These absolute constraints essentially remove land from consideration of alternative uses and so help define rural lands for consideration within the framework. Even absolute constraints can be overcome. However, for the purposes of planning it is helpful to focus analysis on lands that are less constrained.

Lands with absolute constraints whose use is restricted by legislation are assumed to include:

- Reserved lands under the NSW National Parks Act (National Parks, Nature Reserves and State Recreation Areas)
- Declared Wilderness Areas
- Crown Reserves
- Sydney Catchment Authority Lands
- Existing biobanking sites
- Defence Lands (e.g. Holsworthy with potentially unexploded ordinance)
- Land zoned for Open Space under Council Local Environmental Plans
- Lands covered by SEPP 14 wetlands
- State Forests
- Cemeteries.

Action: Identify the above lands and use to define the rural lands for consideration of values.

Individual land uses and strategic framework principles and guidelines are presented in Chapters 2 to 9. Chapter 10 provides a consolidation of the MRA framework. Application of the framework to the GMLRI is provided in Chapter 11.

2 Biodiversity Values MRA

2.1 Biodiversity Overview

Biodiversity, or *biological diversity*, is the variety of all life forms at the genes, species and ecosystem level (Natural Resource Management Ministerial Council 2010). Conserving biodiversity provides a range of ecosystem functions and services that are linked to our physical, social and economic well-being (Natural Resource Management Ministerial Council 2010).

Some biodiversity is conserved in protected areas such as National Parks, reserves, water catchments etc. However, a considerable amount of biodiversity also occurs outside protected areas with greater pressures from land use change or intensification.

A substantial array of legislation, policies and guidelines apply to the assessment, planning and management of biodiversity values on land outside protected areas. This includes the *Commonwealth Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)* and the *NSW Threatened Species Conservation Act 1995 (TSC Act)*.

The *EPBC Act* establishes a process for assessing the environmental impact of activities and developments where 'matters of national environmental significance' (MNES) may be affected. The *EPBC Act* lists endangered ecological communities, threatened and migratory species that have the potential to occur, or are known to occur on a site.

The *TSC Act* aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The schedules of the Act list species, populations and communities as endangered or vulnerable. All developments, land use changes or activities need to be assessed to determine if they will have the potential to significantly impact on species, populations or communities listed under the Act.

Biodiversity values provide a partial but not absolute constraint on rural and other land uses. Processes under the *EPBC Act* and *TSC Act* generally require case by case assessment of impacts and their significance. Government policy also recognises that it is not always possible for impacts to be avoided and so when all feasible measures have been taken to avoid and minimise impacts, offsets can be used to compensate for remaining impacts (NSW Government 2014).

Offsets can also be considered at a strategic level. For instance, Bio-certification was introduced under the *TSC Act* (s.126G) to confer certification of an area if the Minister is satisfied that outcomes in a Biodiversity Certification Strategy will lead to the overall improvement or maintenance of biodiversity values – typically at a landscape scale. In the North West and South West Growth Centres the NSW Government established the Growth Centres Biodiversity Offset Program to permanently protect some of the best remaining bushland in western Sydney and the surrounding areas to offset the impacts on biodiversity that will be caused by the development of the North West and South West Growth Centres.

2.2 Compatibility/Sequencing

Areas identified as having biodiversity value are generally incompatible with other rural or urban land uses.

2.3 A Strategic Framework for Assessing Biodiversity Values

Action

Identify the presence of any threatened species, populations and ecological communities listed under the *TSC Act* and the Commonwealth *EPBC Act* that could potentially occur within the study area.

Identify conservation significance of biodiversity areas.

3 Water Quality Issues MRA

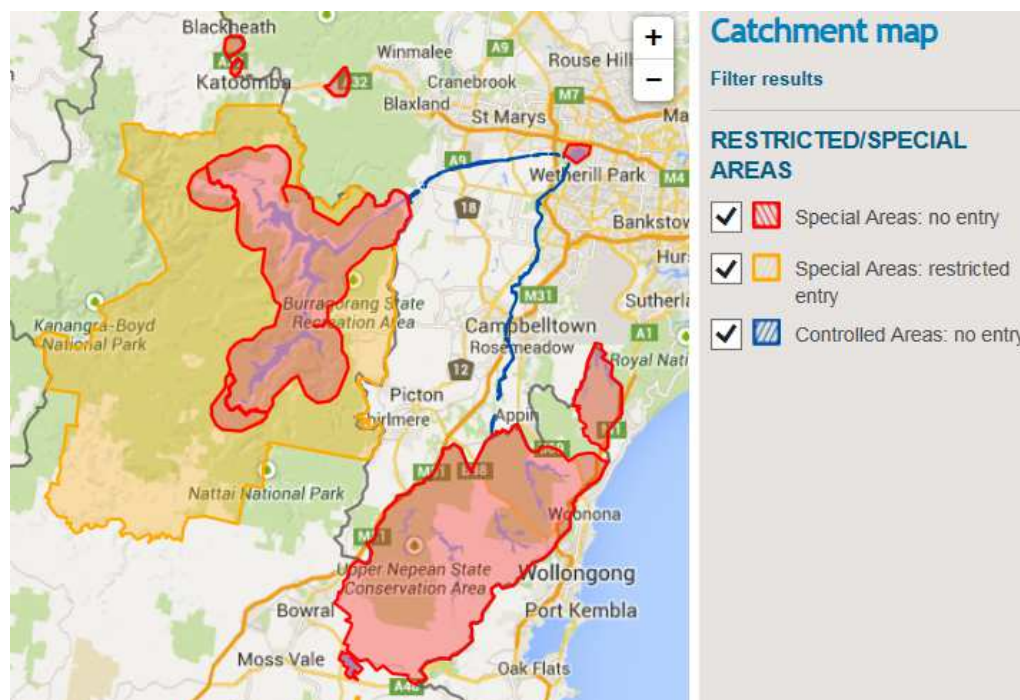
3.1 Water Quality Overview

Water quality is important for drinking, farming, ecosystem and recreational uses.

Sydney's water catchment areas are protected to maintain drinking water quality. Water NSW (previously the Sydney Catchment Authority) maintains a multi-barrier approach which starts with MRA Protected and Special Areas (<http://www.sca.nsw.gov.au/catchment/manage/special-areas>) including:

- Special areas – no entry: These areas include the water storages and surrounding land with the exception of Fitzroy Falls Reservoir and part of Lake Yarrunga, which are classed as restricted entry
- Controlled areas – no entry: These areas include the land at Warragamba protecting the water supply infrastructure and the land along the Warragamba Pipelines and Upper Canal.
- Special areas – restricted entry: These areas include the water storages and surrounding land of Fitzroy Falls Reservoir and part of Lake Yarrunga, and the second protection zone around Lake Burragorang. Vehicles (including motorcycles and bicycles), horses, pets, powered watercraft and firearms are not allowed.
- Restrictions do not apply to privately owned land and public roads within the Special Areas.

Map 3.1 MRA Water Catchment Areas



Source: <http://www.sca.nsw.gov.au/catchment/manage/special-areas>

Every year there is a range of new residential, commercial and agricultural development and activities in Greater Sydney's drinking water catchment.

All proposed developments in this catchment are required by the [State Environmental Planning Policy \(Sydney Drinking Water Catchment\) 2011](#) to have a sustainable neutral or beneficial effect on water quality (NorBE).

Councils in the catchment carry out assessments of these NorBE requirements and refer complex development applications to Water NSW for concurrence.

All public authorities, such as government departments, are also required to assess whether their proposals have a NorBE.

3.2 Compatibility/Sequencing

Restricted and special areas are an absolute constraint on development.

Development in the greater Sydney drinking water catchment is permissible provided it has a sustainable neutral or beneficial effect on water quality (NorBE).

3.3 A Strategic Framework for Assessing Water Quality Issues

Identify restricted and special areas as absolute constraints.

Map streams and waterways that must be protected.

4 Air Quality Issues MRA

4.1 Air Quality Overview

Clean air is fundamental to everyone's wellbeing. Poor air quality can be particularly critical to the health of children, older people, pregnant women and those with pre-existing health conditions, while also affecting the natural environment and liveability of the communities in which we work and reside.

Since the early 1990s a substantial body of research has been published about the adverse health effects of air pollution. The research suggests that air pollution – even at the relatively low levels common in many urban environments of industrialised countries – is a risk factor for health. An increasing range of adverse health effects has been linked to air pollution, especially fine particles.

Short-term exposure to elevated air pollutants exacerbates existing respiratory and cardiovascular problems and increases the risk of acute symptoms, hospitalisation and death ([EPHC 2010](#)). Long-term repeated exposure increases the risk of chronic respiratory and cardiovascular disease and mortality, has an impact on birth weight, and can permanently affect lung development in children ([Pope 2004](#); [Pope & Dockery 2006](#)).

The health costs of air pollution at 2005 levels in the [Greater Metropolitan Region \(GMR₂\)](#) were estimated to be \$4.7 billion or \$893 per head of population ([DEC 2005](#)). Looking at motor vehicle pollution alone, the Australian [Bureau of Transport and Regional Economics](#) estimated health costs of \$3.3 billion per year in the country's capital cities with Sydney's share \$1.5 billion ([BTRE 2005](#)).

Certain key air pollutants that are regulated or subject to standards based on criteria related to health and/or environmental effects are known as 'criteria' air pollutants. To help protect the health of the Australian population, the [National Environment Protection Council](#) in 1998 set ambient air quality standards and goals for six criteria pollutants in the [National Environment Protection \(Ambient Air Quality\) Measure](#) (AAQ NEPM). The six pollutants in the AAQ NEPM are ground-level ozone, particles (as PM₁₀), carbon monoxide, nitrogen dioxide, sulfur dioxide and lead. In addition, an Advisory Reporting Standard for PM_{2.5} was introduced in 2003.

Air quality in Sydney has improved significantly since the 1980s with initiatives to reduce urban air pollution implemented across industry, business, homes and motor vehicles (SOI). The concentrations of four out of the six air pollutants measured under the AAQ NEPM have reduced - carbon monoxide, nitrogen dioxide, sulfur dioxide and lead (New South Wales. Parliament. Legislative Council. General Purpose Standing Committee No. 2 Health impacts of air pollution in the Sydney basin: [report] / General Purpose Standing Committee No. 2. [Sydney, N.S.W.] : the Committee, 2006. – 156 p.; 30 cm. (Report; no. 22).

However, there are significant challenges in reducing the impact of the remaining two air pollutants in the Sydney basin – photochemical smog (ground-level ozone) and particle pollution (NSW Parliament Legislative Council).

Ground-level ozone¹ (a key component of photochemical smog which appears as white haze in summer) remains an issue for Sydney and concentrations have generally continued to exceed national air quality standards between 2009 and 2011 on up to 16 days a year. While all parts of Sydney can experience ozone concentrations above the AAQ NEPM standards at some time, the west and south-west of the city are the regions most often exposed. Western and south-western Sydney's exposure is the result of summertime atmospheric circulation in the Sydney Basin ([DECCW 2010](#)). The number of days when ozone standards are exceeded in any given year is strongly dependent on meteorological conditions, which vary year to year. A statistical analysis to filter out most of the meteorological variability shows ozone concentrations in Sydney are not decreasing (DECCW 2010).

Particle pollution (appearing as brown haze) generally meets standards in Sydney except when bushfires or dust storms occur, though concentrations exceeded national air quality standards on up to 18 days a year from 2009 to 2011.

Geographic conditions can make air quality worse in some locations. Air quality assessment focusses on the relative impact of different land uses. Areas outside a particular location may impact air quality more greatly than any change in land uses in that actual area.

4.2 Compatibility/Sequencing

Air quality issues can be considered an absolute constraint on development if they are deemed significant enough.

It needs to be recognised that there are health costs to society of people residing in areas of poorer air quality.

4.3 A Strategic Framework for Assessing Air Quality Issues

Identify local and regional air quality issues.

Compare study area air quality to other parts of the Sydney metropolitan area.

5 Agriculture Values MRA

This chapter includes an overview of agricultural values and a strategic framework for their assessment.

¹ Ozone is formed in the lower atmosphere when a number of 'precursor' compounds – mainly oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) – react in warm, sunny conditions. (Carbon monoxide is a lesser source of ozone as well.) Major anthropogenic sources of NO_x and VOCs include emissions from industrial facilities, electric power stations and motor vehicle exhausts, and fumes from engines used in garden equipment and recreational boats as well as paints, aerosols and solvents used in homes and businesses. It is also important to note that natural sources, such as eucalyptus trees, contribute approximately 55% the total emissions of volatile organic compounds in the GMR₂

5.1 Agriculture Overview

Agriculture is a production system that uses land, labour and capital to produce food, fibre and ornamental products for own consumption or, more typically, for sale. Agriculture in the Sydney MRA is mainly concerned with food and ornamental (cut flowers, nursery and turf) production.

Sydney residents source their food through multiple supply channels including mainstream retail (e.g. supermarket chains, independent retail, convenience stores, online delivery, etc.), wholesale markets such as Flemington, farmers markets such as the Camden Fresh Produce Market, roadside sales, etc. Mainstream retail accounts for approximately 90% of Sydney's food needs. Alternative outlets (wholesale markets, farmers markets, roadside sales, etc.) account for approximately 10% of Sydney's food needs².

In order to meet consumer demand for year round variety and value, mainstream retail sources fresh food on a national and increasingly international basis. For example fresh strawberries are sourced for Sydney from Victoria during the summer months and from Queensland during the winter. Furthermore, Australia has international trade obligations that require it to accept food from countries where that food meets Australian sanitary and phytosanitary requirements. In return, Australia has access to valuable export markets and delivers up to 70% of all its fresh food to export destinations.

Trade allows agricultural producers to specialise in what they do best and produce more than could be consumed in a local catchment. Domestic and international trade is supported by sophisticated and many layered supply chains with built in redundancies that ensure supply continuity in the event of disruption.

Agricultural product supply is not static, investment in research and development (R&D), technological change and innovation has ensured an increasing supply of calories per head of world population and declining real prices of agricultural food products over a long period of time (ABARES 2011). A shortage of calories in some locations is associated with capacity to pay at ruling market price rather than a shortage of food.

Trade and a very strong production base ensure that food security is not a problem for Australia in either the short or long term. 'Food security refers to the ability of individuals, households and communities to acquire appropriate and nutritious food on a regular and reliable basis, and using socially acceptable means. Food security is determined by the food supply in a community, and whether people have adequate resources and skills to acquire and use (access) that food' (NSW Centre for Public Health and Nutrition 2003). 'Australia produces far more food than it consumes and has the income to meet all its food security needs' (ABARES 2011, p. 1).

Identification of more valuable agricultural land is facilitated by land and soil capability assessment. In NSW, the Office of Environment and Heritage (OEH) has developed a Land and Soil Capability Assessment Scheme (OEH 2012). The scheme classifies land into eight classes:

² Informed estimate prepared by agricultural economist Michael Clarke and based on the knowledge that, on their own, the two dominant supermarket chains (Coles and Woolworths) supply 70% of Sydney's food needs

- Class 1: Extremely high capability land: land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
- Class 2: Very high capability land: land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
- Class 3: High capability land: land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
- Class 4: Moderate capability land: land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
- Class 5: Moderate–low capability land: land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
- Class 6: Low capability land: land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
- Class 7: Very low capability land: land has severe limitations that restrict most land uses and generally cannot be overcome. Onsite and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
- Class 8: Extremely low capability land: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

Class 1 and Class 2 land is highly arable land with the greatest potential for food production. Class 3 land, while capable of crop production, is undulating with slopes of up to ten percent, is more restricted in its use for broadacre crops and horticulture, and is relatively abundant throughout the NSW Wheat-Sheep Zone where it is held in large and contiguous commercial holdings. Class 1 and 2 land therefore provides the greatest agricultural constraint on urban development.

Bonney *et al* (2015) point to the importance of identifying and promoting the indirect contributions that agriculture and rural industry makes to regional development and regional economies. One way this can be taken into account is through cluster analysis and consideration of both direct and indirect employment.

Agricultural clusters are one way of thinking about the agricultural value of land in the MRA and making sure that linkages, including processing and employment linkages are fully considered. 'A Plan for Growing Sydney' identified thirteen preliminary agricultural cluster groups in the MRA (APFGS, 2014, page 99). These include:

1. Fruit trees – Bilpin
2. Hawkesbury River multi-use cluster – between Windsor and Richmond
3. Irrigated horticulture (vegetables and herbs), Warragamba – Silverdale, Wollondilly LGA
4. Irrigated seasonal horticulture (vegetables and herbs) – west of Rouse Hill
5. Multi use horticulture cluster (vegetables and tree fruits) – Maroota
6. Multi use horticulture cluster (vegetables, tree fruits) – Middle Dural, Galston, Arcadia
7. Multi use horticulture cluster with sparse poultry sheds – Central Coast
8. Multi use irrigated horticulture cluster, large lot sizes – Cobbitty and Camden
9. Multi use seasonal horticulture, poultry sheds, small lots – Horsley Park to Leppington
10. Poultry sheds – Appin, Wollondilly and Campbelltown LGAs
11. Production forestry – Central Coast
12. Seasonal horticulture with poultry sheds – Riverstone and Marsden Park
13. Seasonal horticulture – Shane Park, Llandilo and Berkshire Park (Penrith LGA).

Note: Some areas above have already been identified for urban development.

An industry cluster is a group of proximate firms 'interlinked by input/output, knowledge and other flows that may give rise to agglomerative advantages' (Lublinski, 2003: 4543). This concept relates to the idea of economies of scale and network effects. Simply put, as more firms in related industries cluster together, costs of production may decline significantly (firms have competing multiple suppliers, greater specialisation and division of labour result). Even when multiple firms in the same sector (competitors) cluster, there may be advantages because that cluster attracts more suppliers and customers than a single firm on its own.

Agricultural clusters can impact the estimated potential net value of land for agriculture and so should be taken into consideration when assessing the net market value of potential agriculture from land. Clusters can result in reductions in cost of production through scale effects and networks. However, as identified by Porter (1990)⁴ in his seminal work on clusters, 'clusters are not unique, they are highly typical'. Industry clustering shifts the focus from the performance of the firm to inter-firm linkages. Clusters are not static; they grow, evolve, mature and die, primarily in relation to market forces (Johnston 2003)⁵. For example a cluster may die when

³ Lublinski AE (2003) Does geographic proximity matter? Evidence from clustered and non-clustered aeronautic firms in Germany. *Regional Studies* 37(5): 453–67.

⁴ Porter, M.E. (1990) *The Competitive Advantage of Nations*, Macmillan, London.

⁵ Johnston, R. (2003) Clusters: A Review, prepared for the Mapping Australia's Science and Innovation System' Taskforce, Department of Education, Science and Training.

there is a fundamental change in market dynamics and or government policy – the recent demise of a car manufacturing cluster in Elizabeth South Australia is a case in point. Because of the potential agglomeration advantages of a cluster, alternative land uses e.g. mining or housing, can also result in the development of industry clusters.

The existence of clusters therefore points to the strength of linkages in an economy between firms and requires consideration when analysing the opportunity cost of changes in land uses.

Clusters can be associated with employment ‘hot spots’. While direct employment in agriculture as measured by the Australian Bureau of Statistics (ABS) may point to only modest numbers of jobs, consideration of the cluster, and critically, employment associated with agricultural processing of commodity generated in the cluster may point to a higher than anticipated economic contribution. Agricultural processing can take place on farm (e.g. trimming and packing vegetables for market) or in nearby towns/employment areas (e.g. abattoirs for processing broiler chicken). A framework for considering agricultural values in the MRA must include analysis of both direct and indirect employment in agriculture.

Land currently employed in agriculture is potentially an input into future urban, rural residential, mining and biodiversity offset land uses. That is, by using the land for alternative uses it may not be available for agriculture. In economics, the significance of these impacts is determined by their opportunity cost which is the foregone potential net returns from agriculture (readily measured as the present value current and future agricultural enterprise gross margins). In a competitive market, the potential gross economic value of agricultural production is reflected in the prices received for the goods that are produced and the economic costs of production are reflected in the costs of inputs.

In a properly functioning land market, the present value of the potential net financial benefits of potential future agricultural production (including expectations about food security, health benefits of production, etc.) is reflected in land price. Unless there is a demonstrated failure in agricultural markets to adequately reflect the scarcity of agricultural products or a failure in land markets to adequately reflect the scarcity of agricultural land, then the market price of land reflects, among other things, the opportunity cost of using that land for alternative uses. However, land prices may substantially exceed the present value of agricultural production where there are expectations that the land may in the future be able to be used for higher value uses, such as urban.

Price also determines which agricultural commodities will be produced and where. Agriculture uses price signals to move to those locations that offer the most profitable combination of land, labour and capital. Over time commercial agriculture, including ‘high tech’ greenhouse based industries have moved out of high priced peri-urban areas to more profitable locations. For example Guyra in north western NSW is now the centre of Australian tomato production using state of the art greenhouse technology. Previously tomato production was dominated by Bundaberg Queensland where the fruit was grown outdoors, in soil, on high value coastal land.

5.2 Additional Agricultural Values and Contemporary Land Use Planning

In addition to food production value, the community may also assign additional values to agriculture in the MRA. Some of these additional values are already reflected in market price of

produce and land price while others may not. The Sydney Agriculture Strategic Approaches (SASA) Working Group (document supplied 9 March 2015) and other thoughts and policies on additional values associated with agriculture are reproduced in Box 1. These thoughts are presented without analysis so as to capture at least part of the breadth of possible public concern associated with use of agricultural land for other purposes. Consideration and analysis of these issues becomes part of the agricultural analysis framework. Analysis of these issues, as they apply to the study area, is provided in Chapter 11.

Box 1: SASA and Other Policies Relating to the Importance of Maintaining Agriculture in the Sydney Basin

Economic development: Peri-urban agriculture needs to be recognised for the important role it plays in the economy, not only in actual agricultural production but also in food processing:

- In 2011 Sydney Statistical Division agriculture contributed \$749 M or 6% of the NSW \$11.7 B gross value of agriculture production this being the highest NSW coastal value of production region.
- The area of agricultural production was estimated to be 125,000ha, and therefore a significant land resource. There were 2,210 farms employing 7,069 workers.
- In certain times of the year the Sydney region produces 90% of some perishable vegetable commodities and is the most important area in Australia in terms of value of production for Asian vegetables.
- There is a need to considering the multiplier effect of agriculture in terms of employment provision.
- The production value of poultry was 40% to the total gross value of agricultural production (\$298 million) and vegetables accounted for 22% (\$167 million) of NSW production.

Employment creation

- Loss of agriculture is also the loss of significant secondary industries associated with food processing (e.g. poultry abattoirs) and consequently the loss of local employment. While farms are individual units the multiplier effect in terms of employment provision must be considered. The poultry sector alone provides an estimated 20,000 direct jobs.
- Because of high labour requirements, agriculture, especially intensive agriculture, provides significant employment to people living in adjacent areas. Unemployment in some peri-urban LGAs in Greater Western Sydney is almost double the national average and with the projected population growth the region is forecast to have a jobs shortage of around 290,000 by 2036 according to the previous Metropolitan Strategy.
- Agricultural industries employ many people from culturally and linguistically diverse backgrounds, including recent migrants and refugees and can provide business opportunities for groups that may not have many alternative employment options.

Environmental benefits and costs: There needs to be recognition of the positive and negative effects agriculture has on ecosystems: biodiversity, water quality, carbon sequestration and scenic amenity, enabling rural based tourism and the provision of services that protect these amenities.

- Agricultural lands provide important environmental services for both the natural and built systems of the Sydney region. Retaining agricultural lands will provide biodiversity and other benefits, including allowing for effective groundwater recharge and maintaining soil quality.
- Loss of agriculture represents a threat to biodiversity and a loss of groundwater recharge and soil quality, an increase in feral animals, weeds and pests and a reduction of native flora and fauna through competition and predation.

- Well managed productive farmland by its nature discourages feral animals and weeds that reduce native flora and fauna through competition and predation.
- Unproductive 'rural land in waiting' for urban development, generally promotes exotic weeds and is a haven for feral animals and pests, posing a serious threat to biodiversity. It is considered as 'vacant land' as whilst not productive it is often being actively managed to avoid any increase in biodiversity value.
- Agriculture is a good form of buffer between protected areas and urban development if managed well. It also performs important environmental services.
- **NSW Farmers MOU** with the NSW Government recognises the important role farmers play as environmental custodians.

Food security

- In order to create a sustainable city it is essential that a substantial amount of production takes place in close proximity to the consumer to ensure freshness, reduce carbon footprint and increase agricultural output. If a natural disaster were to occur these supply lines –Sydney's fresh food reserves are estimated at two days' worth of perishable consumption based on the throughput of the Sydney Flemington Market. Changing trends in food demands, having a competitive advantage over other products because of their freshness, locally grown and no food miles involved.
- There is now much heightened awareness of the importance of foods and the fragility of the systems that support it. A whole new agenda has emerged about food that is developing into a significant political and economic force influencing government policy.
- Over 50% of NSW vegetables are grown in the Murray, Murrumbidgee region where water availability is becoming a significant problem. Sydney has good agricultural land and may also have better rainfall than inland as climate change occurs. The capacity for Sydney to continue to provide vegetables should be increased.
- The population in Greater Western Sydney area which is currently around 1.9 million and is expected to increase by over 1 million in the next 20 years, increasing significantly local demand for fresh produce.
- The loss of agricultural land may have profound impacts on levels of food production, transport, food prices and the quality of perishable products and on food security. Sydney imports the bulk of its vegetables from outside the region which raises concerns regarding the ecological footprint created through travelled food miles and food security.
- Loss of agricultural land may also have an adverse effect on food security. Sydney imports the bulk of its vegetables from outside the region. There are concerns that it promotes continuing disregard for the heavy ecological footprint created through travelled food miles.

Health benefits

- Health and nutrition are major issues in Western Sydney where 60% of the population is classified as overweight or obese and incidences of diabetes were running at up to 7.4% of the population. Seven of the top nine areas for diabetes in Sydney are in the West.
- Nutrition remains a key problem in Western Sydney where obesity and other diet and lifestyle related illnesses are already above the national average and rising.
- **'A Plan for Growing Sydney'**: Direction 3.3 (page 89, point 3) identifies the need for a built environment that can provide equitable access to healthy food – for example retaining peri-urban agricultural lands as a source of easily accessed healthy food and providing space for farmers' markets and community gardens

- **NSW Health (2013) 'Healthy Eating Active Living Strategy'**: identifies a number of policy objectives relevant to consideration of agriculture in the MRA, these include: (creating) environments to support healthy eating and active living; reduce intake of energy-dense nutrient poor food and drinks; and increasing consumption of fruit and vegetables.

Tourism perspective

- Landscapes of the Sydney region include heritage and tourism assets and form an important recreational and leisure asset for Sydney residents
- Agricultural lands also provide a link between urban Sydney and rural NSW, which has value from a tourism perspective.

Contemporary land use planning has made various attempts to accommodate the additional values outlined above into land allocation decisions e.g. Food Sensitive Planning and Urban Design (FSPUD) (Donovan *et al* 2011) and the current University of Technology Sydney (UTS) Sustainable Futures 'Food Sheds' project (Plant 2014).

FSPUD offers a conceptual framework for achieving sustainable and healthy local food systems. The framework shows how local food production, processing, transport, waste management and consumer expectations might be brought together in a system that improves livelihoods, sustainability, resilience, community, health and fairness (Donovan *et al* 2011). The FSPUD conceptual framework is yet to be applied to a community in either Australia or overseas.

'Food sheds' are land areas that could potentially feed peri-urban and regional centres in selected local government areas in Western Sydney. Mapping peri urban land on the basis of its potential agricultural food production value would enable councils and state government to reserve important agricultural land for future generations and promote agricultural industry investment. Spatial-temporal measures and metrics are required to understand the geography of food production in Western Sydney. The UTS Institute for Sustainable Futures 'Food Sheds' project includes an evaluation of the feasibility and desirability of reconfiguring the local food production system. In addition to food, local agriculture could be protected to produce bundles of ecosystem services including heat mitigation, lowering the consumption of greenhouse gas intensive food, habitat provision and living green infrastructure (Plant 2014).

It is noted that both these alternative land use planning frameworks would require a major policy shift on existing zones, permissible land uses, buffers such that agriculture is prioritised. Alternative farming approaches would also have to be financially viable and desirable to actually occur.

The NSW Agriculture Industry Action Plan (NSW Government, 2014) made a series of recommendations, recommendations 25 and 26 are relevant to MRA framework development:

Recommendation 25: (agricultural) industry to actively engage in the implementation of the NSW planning reforms through regional and local plan development processes including articulation of its investment strategies and proposing ways to effectively manage conflict.

Recommendation 26: Government to ensure equity and transparency in the resource planning process through the State planning reform to ensure the improved security of farm tenure and access to valuable natural resources for agriculture.

5.3 Compatibility/Sequencing

In the MRA, agriculture is mostly in direct competition for land with urban development and rural residential because of its proximity to the metropolitan area. Often land in close proximity to existing urban areas, suitable for urban development, has moderate to high agricultural value.

Where land has been identified for urban development, extensive grazing enterprises on larger lot sizes can be compatible until development commences. Intensive animal enterprises (e.g. poultry production) are not compatible with housing unless large buffers are provided.

Vegetable production, turf and other forms of ornamental horticulture can be sustained on land not suitable for urban development e.g. land subject to flooding.

5.4 A Strategic Framework for Assessing Agricultural Values

Using the above knowledge the following strategic framework is proposed for assessing agricultural values in the MRA:

Guiding Principles that Inform the Agricultural Framework

- The main value of agricultural land to the community is the food, fibre and ornamental horticulture it produces or can potentially produce
- Additional values have been proposed by a range of stakeholders. These additional values need to be correctly described and analysed to determine their relevance to a study area
- The key determinant of where and what agricultural production occurs is the cost of inputs (including land) and the price of agricultural products. The price of agricultural products reflects the scarcity of food, transport costs and expectations about future global food security. The price of land reflects, amongst other things, its ongoing ability to produce agricultural products. The price of agricultural land within close proximity of urban areas may also reflect expectations about future re-zoning
- Land zoned for urban development can still be used for agricultural production pending actual development. If land is of higher value in agriculture following rezoning there will not be a change in land use
- There are a suite of tools available for the analysis of agricultural values. These include opportunity cost assessment using comparative land values, land and soil capability mapping and agricultural cluster analysis.

Framework for Determining Agricultural Values

1. Document the agriculture 'big picture':
 - So that decision makers and the NSW community can be confident that agricultural values are being correctly identified and described.
 - Analysis of the 'big picture' will include sources of agricultural product supply, changes in supply over time and the benefits of trade for producers and consumers.
 - Correctly described the 'big picture' will show the relevance of study area agriculture to Sydney and the NSW economy.
2. Describe additional values that stakeholders might attribute to study area agriculture. A checklist of additional values that stakeholders may wish to add to includes:
 - Food security - now and in the future
 - Health benefits – the superior health attributes of locally sourced food
 - Economic development and employment created – on farm and processing
 - Tourism – road side produce sales, farmers markets and agricultural vistas
 - Cultural values – does local agriculture provide a focus for community groups.
3. Collate objective data on agricultural values in the study area:
 - Gross Value of Production (ABS)
 - On farm and processing employment (ABS)
 - Agricultural enterprise values to determine land value (NSW DPI)
 - Study area land and soil capability (OEH)
 - Clusters of agricultural activity with linkages including employment (APFGS 2014)
4. Document a shortlist of priority agricultural industries and locations.
5. Identify the value of potential agricultural production from the land.
6. Look for co-existence and sequencing opportunities for agriculture:
 - Which areas can be zoned for high priority agriculture at no or low opportunity cost (e.g. floodplains for vegetables and ornamental horticulture)
 - Land rezoned for housing may continue to support agriculture until development begins (e.g. extensive cattle grazing).
7. Map highest value agricultural land:
 - Best agricultural land – Class 1 or 2
 - Land that can be protected at low or no opportunity cost for important agriculture.

6 Mining / Natural Resource Values MRA

This chapter provides a framework for assessing mining values. An overview of coal mining, coal seam gas, and quarry resources within the GMLRI is presented but more detail of these operations is provided in Section 11.6 where the framework is applied to the GMLRI. A framework for assessing mining values is also provided.

Within the GMLRI, there are large coal and coal seam gas resources currently being extracted. Sandstone construction materials are also being quarried.

Coal resources exist in multiple seams located across almost all of the GMLRI at depths ranging generally from about 400 m up to about 850m below the surface. Coal seams that have been previously mined in the Southern Coalfield include from the uppermost down, the Bulli Seam, the Balgownie Seam, the Wongawilli Seam, and the Tongarra Seam. There may also be some areas within the GMIA where the Hargraves, Cape Horn, American Creek, Woonona, Figtree and Unanderra Seams are thick enough to mine but exploration for these seams is limited and there are currently no known plans to mine any seams other than the Bulli Seam. The Bulli Seam is the target seam for all the current mining operations within the GMIA because of its high coking coal value. The Wongawilli Seam and Balgownie Seams may also be targeted in future but extraction of the overlying Bulli Seam will complicate such mining. The Wongawilli Seam has particular importance as a resource because, when blended with Bulli Seam coal, a high quality coking product is produced.

Coal seam gas resources are associated with the presence of coal and exist across almost all of the GMLRI. Existing large scale exploitation of this resource is mainly associated with the Camden Gas Project located southwest of Campbelltown. This project supplies about 5% of New South Wales's gas needs (AGL 2015). There are also several small scale operations integrated with coal mining operations within the GMLRI. Significant gas reserves remain in unmined coal seams. Additional reserves that are more easily accessed and are therefore cost competitive may become available in coal mines once mining is complete.

Existing and potential reserves of construction materials (sand and crushed sandstone) are located within the GMLRI with two quarry sites identified near Menangle. The Regional Environmental Plan No. 9 – Extractive Industry No. 2 – 1995-574 (NSW Government 2015) identifies these as regionally significant.

The legal framework to manage mining and other extractive industries is well established at a State Government level, although this framework does appear to have been relatively dynamic in recent times, particularly in relation to coal seam gas. Federal regulation is limited to the Environment Protection and Biodiversity Conservation Act 1999 and impacts on water resources and flora, fauna, ecological communities, and heritage places. Quarrying operations are generally controlled at a local government level.

6.1 Mining Overview

Active coal mines operating within the GMLRI employ the longwall method of extraction. Longwall mining is the most efficient system of underground mining and currently the only

economically viable option for recovering coal resources in this location due to the depth and nature of the coal deposit. Operational and safety requirements for ventilation and gas management are major considerations for how coal mines are laid out.

Coal mining operations have potential to cause surface impacts in a variety of ways including surface subsidence, exploration and gas drainage activities, ventilation and power supply infrastructure, subsidence mitigation and remediation activities, as well as noise, dust, transport, water discharge, and other activities largely confined to the pit top area and adjacent transport routes. In a semi-rural setting with only small, isolated townships, these impacts can generally be managed without undue inconvenience to the community at a cost that allows mining to remain profitable and therefore viable.

In the Southern Coalfield, longwall operations typically cause vertical subsidence of up to 1-2 m over the centre of each longwall panel with lower subsidence nearer to the edges of each panel. Permanent tilting of the land surface occurs around the edges of each panel but at generally low enough levels to be largely imperceptible and tolerable. Horizontal ground movements also occur in response to the vertical movements and these tend to generate zones of stretching where tension cracks may become evident or zones of compression where the ground is squashed and shortens. In some circumstances, these horizontal movements may become focused at one location and cause localised damage to structures above background levels.

At any given point on the surface, subsidence impacts associated with longwall mining at depth occur within the period of active mining of the panel directly below and the period of active mining of adjacent panels. The period of most change typically occurs within 1-2 months during active mining with some additional change a year or so later and possibly again a year or so later when the adjacent panels are mined. Once mining in an area is complete, subsidence is also complete and there is generally no potential for further subsidence impacts.

From a purely subsidence impact perspective, the concept of co-existence of mining operations and urban development is possible for residential properties, most types of urban infrastructure, and some types of commercial and industrial developments. Design and construction methodologies to accommodate subsidence impacts are well developed but some more significant structures may not be able to tolerate large subsidence movements and the only option is to avoid mining near them.

In New South Wales, the legal framework to manage coal mining is well established at a State Government level. There is a mechanism in NSW to manage the costs of the rectification of damage to properties caused by mining subsidence through the Mine Subsidence Board. This mechanism does not cover consequential losses to businesses, repair of damage to structures that are constructed after the declaration of Mine Subsidence Districts but do not meet the design requirements, the costs of maintaining public safety, or the costs associated with managing impacts to the natural environment or anything that is not a built feature. The costs of managing these consequential impacts are a direct cost to the coal mining operation.

The price of coal and other commercial considerations have a strong influence on the viability of coal mining operations. The level of funding available to manage surface interactions in ideal market conditions may not be available when market conditions deteriorate. For instance, the

experience of mining at Tahmoor Colliery below the township of Tahmoor indicates that even when the price of coal was unusually high, the density of residential urban development that were present above five longwall panels made the combined impacts of mining difficult to manage at a cost to the community and government that was tolerable and at a cost to Glencore that allowed mining to remain viable and the resource to be recovered.

Other types of impacts associated with exploration and gas drainage drilling, certain types of ventilation shafts (upcast) and the noise they produce, and mitigation and remediation activities associated with managing subsidence impacts are more difficult to manage in an urban environment, particularly one where the people impacted by mining are not necessarily closely associated with or derive any direct benefit such as employment from the mining industry. Furthermore, impacts related to ventilation and gas drainage can be ongoing for extended periods both before and after active mining.

Significantly, the cumulative effects of community intolerance of subsidence and other impacts, whether real or just perceived, can impact the social licence of coal mining and coal seam gas operations to exist. This cumulative effect tends to be greater in an urban environment simply because of the larger number of people impacted.

6.2 Interaction of Coal Mining with Urban Development

The sequencing of mining ahead of urban development has potential to significantly reduce the overall cost to the community of recovering a valuable resource. Once mining is complete, the potential for further subsidence is eliminated, and only the ongoing impacts related to ventilation shafts and pit top impacts need to be managed.

However, there is also a cost to the community of forestalling urban development in anticipation of mining. In the short term, up to about 7 years, the certainty that mining will occur in a particular geometry is high and the costs of delaying surface development have potential to offset the costs of repairing subsidence impacts sufficiently to justify sequencing mining before urban development. In the longer term, 15-30 years, the certainty that mining will occur in a particular geometry or that a particular mine will continue to be operational tends to reduce because exploration activities are yet to be fully completed and the mine plans tend to be largely conceptual. Even though approval to mine has been granted, such approval does not guarantee an operation will remain viable. When this lack of certainty is coupled with the costs of delaying surface development, the argument for forestalling surface development to accommodate future mining becomes less convincing.

In the 7-15 year period, there may be potential for staged development in areas where there is certainty of mining and subsidence can be accommodated. This potential can be determined on a case by case basis by considering the balance between the economic value of coal resource to the community and the economic value of the surface development less the cost of repair.

There is no explicit commitment in the granting of a coal lease and/or approval to mine that limits future surface developments in the area to be mined. Coal mining companies have the opportunity to object to surface developments as part of the normal planning approval processes but ultimately, when an area is planned to be mined, the impacts of mining have to

be managed for the surface development as it exists at the time of mining. If there has been surface development in the period between granting of the lease and the time of mining, the impacts of mining on these additional surface developments need to be managed.

In practical terms, the effect of urban development, and particularly commercial and industrial developments and high density residential developments, tend to drive up the cost to the community through the inconvenience caused by mining and the cost to the mining company through the added costs of managing subsidence and other operational impacts. Commercial and industrial developments are also more expensive to manage because they tend to involve larger structures and attract additional costs associated with consequential losses caused by interruption to business. Consequential losses are not covered by the Mine Subsidence Board and need to be funded by the mine.

At some point, the added costs associated with an increased proportion of urban development preclude economic mining so the coal resource is effectively sterilised. Based on the experience of mining at Tahmoor Colliery (discussed in the next section), the concept of co-existence of coal mining and urban development is not really practical once the area of residential development increases above a critical level of about 20-30% because of the high costs to the government and mining company involved with managing subsidence and the high cost to a few in the community whose houses are significantly impacted. This critical level is likely to be less if the surface development includes industrial and/or commercial developments such as hospitals, shopping centres, industrial plant, and other major infrastructure.

Ideally, for the best overall outcome to the community, surface development would be sequenced so that development occurs in those areas where mining has already been completed and mining is prioritised in those areas where there is greatest pressure for urban development. However, for such sequencing to be most effective there would need to be an ongoing dialogue between government, coal mining operations, and surface developers with all three showing some flexibility. Currently there does not appear to be an effective mechanism in place that encourages this type of interaction.

Tahmoor Experience

Sheppard et al (2014) describe how Tahmoor Colliery mined five longwall panels affecting approximately 1550 houses, a number of public amenities and commercial establishments, 20 km of local roads, the Main Southern Railway, two road bridges, and many kilometres of potable water, sewerage, gas, electrical, and telecommunications infrastructure. The main shopping centre and a poultry processing factory were not directly mined under but were nevertheless affected by subsidence movements. About 30% of the residential structures were reported as being impacted, but the majority of these impacts were slight, sticking doors, minor impacts to internal walls, ceilings, and floor finishes. Approximately 3% of these structures experienced moderate or greater impacts and some structures where the cost of repair was estimated to be greater than replacement were demolished and rebuilt.

Sheppard et al (2014) conclude that the “experience gained at Tahmoor illustrates that longwall mining beneath urban areas is sustainable and can be successfully managed to mitigate the

impacts on surface developments. However, it does come at a significant cost to the mine, and at times, a high social cost to individuals within the local community”.

In the seven longwall panels discussed by Sheppard et al (2014), urban development covered approximately 30% of the total area of these panels. The panels were mined during a period when coal prices were high so that greater resources were available to manage subsidence impacts compared to periods when coal prices are at more subdued levels.

Other significant factors are that Tahmoor Colliery did an excellent job of managing community relations, the community is sympathetic to mining because the mine provides local jobs and economic benefit to the town, and Tahmoor Colliery manages its methane gas drainage entirely from underground so gas drainage holes are not required to be drilled from the surface during mining. There is also sufficient vacant land within the mining lease to locate ventilation infrastructure (fans and shafts) without significantly impacting the local community.

The conclusions reached by Sheppard et al in relation to illustrating that mining beneath urban areas is sustainable should be recognised as relating to subsidence impacts in mainly residential areas where gas drainage is not required and there are sufficient vacant lands to site mine ventilation infrastructure remote from residential dwellings when the price of coal is high enough to support significant surface works to manage surface impacts.

In areas within the GMLRI, surface gas drainage infrastructure is likely to be required for operational and safety reasons and coal prices are no longer at the levels they were during the period of mining below Tahmoor. A density of residential development of even 20-30% of the total mining area is expected to significantly impact on the viability of current mining operations in the area.

Proposed Management of Subsidence Impacts at Wilton Junction

Mine Subsidence Engineering Consultants (MSEC 2014) presents a review of the key issues related to subsidence impacts with particular reference to the Wilton Junction Development Proposal. The review indicates that it is possible for residential development to occur prior to coal mining and the impacts can be managed through specific construction design to accommodate subsidence although it should be noted that the review focuses on subsidence impacts rather than impacts associated with exploration, gas drainage, and ventilation infrastructure.

In the Wilton Junction Development Proposal, there are some structural design options to help protect some types of more significant infrastructure, such as shopping centres and industrial buildings, but in general these are best located in areas where subsidence is not expected to occur such as over main heading developments or beyond the edges of longwall panels. The costs and practical challenges of managing subsidence impacts on these types of larger structures tend to be significantly greater than for residential structures, especially when issues such as consequential losses due to business interruption are taken into account.

MSEC estimate the additional cost of design modifications for residential structures to be a 1-3% increase for the householder, but the actual cost of managing mine subsidence impacts in a fully urban environment is likely to be significantly greater given the costs associated with

community liaison and managing community anxiety and construction compliance.. The costs for a small number of people whose houses are damaged are much more significant with disruption to their lives while their houses are repaired or demolished and rebuilt.

International Mining Consultants (IMC 2014) conducted a similar review for the Wilton Junction Development Proposal in relation to surface infrastructure and gas drainage considerations. This review looked at a range of different gas drainage options and concluded that coexistence of underground mining and urban development was not unique. IMC noted that they were not able to find in the available literature any examples of co-existence of surface based gas drainage operations, whether due to the fact that the undermining pre-dated the use of these techniques, lower gas level obviated the need for goaf drainage, or, as at Tahmoor, surface based gas drainage methods are not used.

IMC did not specifically look at ventilation shafts because their review was for the Wilton Junction Area remote from where any ventilation shafts are planned to be located. The main issue with upcast ventilation shafts from a community perspective is the noise they generate and the buffer that needs to be applied around them.

Assessment Challenges

One of the challenges for assessing mining values is uncertainty about possible longer term mining activities, particularly if detailed exploration drilling has yet to be completed. The presence of a coal resource does not necessarily mean that it is either profitable to mine the coal or that there is any intention to do so in the foreseeable future. This outlook can change relatively rapidly at some point in the future depending on the price of coal and the economic climate (mining approvals for major projects currently require timeframes of approximately 4 -5 years duration). IMC (2014) identified the need for “open and meaningful discussions” with the relevant mining company in relation to expected exploration and gas drainage requirements. This cooperation seems essential if an optimum balance is to be achieved for the community as a whole.

The presence of urban development on the surface and the costs of managing the impacts of mining activities on surface developments both reduce the profitability of mining operations and inflate negative reactions within the community that impact on the social license of mining operations to exist. This effect has tended to drive mining operations to design layouts, where possible, that avoid impacting on urban developments. Recent examples include the Bulli Seam Operations layout that minimises extraction directly under the township of Douglas Park.

Where the development centres are isolated townships, there is scope to arrange the mine layout to minimise impacts by placing main headings, which do not cause subsidence and may have different gas drainage requirements, so as to protect areas of urban development. This capacity diminishes as the density of housing increases. The surface gas drainage practices that ICHPL currently uses in a semi-rural environment are not consistent with mining in fully developed urban areas where there is a mix of residential / commercial / industrial development.

Even though, from a purely engineering perspective, it may be possible to manage subsidence impacts within a largely residential environment, there are multiple other issues that limit the practicalities of mining in this environment.

The cost of managing subsidence impacts increases as the density of urban development increases. There is a particularly high cost to some individuals within the local community and a significant cost to the mining company and government (Mine Subsidence Board and regulators) to manage these processes. For context, only about 20-30% of the surface area above Tahmoor Colliery was urban residential area, mining occurred during a period when coal prices were high so there were greater resources available to support community liaison, mitigation, and remediation activities.

Managing impacts on commercial and industrial enterprises is difficult, expensive, and may not be possible in some cases. For context, Tahmoor Colliery did not mine directly under the main shopping centre, a poultry processing plant, and is yet to mine under industrial parts of Picton, so the experience of mining under large commercial or industrial sites is relatively limited and likely to be expensive to manage effectively.

Managing interaction with gas drainage and other mining infrastructure may be a greater problem than managing subsidence impacts. Tahmoor did not undertake exploration drilling within the urban areas or undertake gas drainage from the surface.

6.3 Framework for Assessing the Interaction of Coal Mining and Urban Development

A framework for assessing the potential for co-existence and sequencing of mining and urban development needs to recognise a number of factors. These include:

- The uncertainty in mining.
- The variable economic benefits of mining.
- The limited nature of the coal resource.
- The costs of delaying urban development.

These values change over time and with the level of urban development. A framework for assessing mining values relative to surface values can be based on considering the net present value of future coal mining recognising that this value diminishes over time and the losses associated with delaying surface development which increases over time. In this way, the time to a cross over point can be estimated as the basis on which surface development should progress at the expense of possible loss of coal resource.

Co-existence

Based on the Tahmoor experience, co-existence of mining and urban development is considered unlikely to be practical or economic once the proportion of residential development increases above about 20-30% of the surface area above a proposed mining domain. A lesser proportion is likely to apply to larger commercial, industrial, and community infrastructure. A single longwall panel may be economic to mine below a higher proportion of urban development if the higher costs of managing surface impacts can be balanced by reduced costs

above other panels within the mining domain. Issues of community concern, the cost of managing impacts, and the challenges to surface access for mining related activities all increase as the proportion of urban development increases. Thus residential development that is greater than about 30% of the surface area above a mining domain is likely to have the effect of sterilising the coal. A smaller proportion of urban development may have a similar effect depending on the coal price, nature of the surface development, community acceptance of the impacts of mining, and a range of other factors.

In effect, the concept of co-existence of mining and urban development at a density approaching 100% of the surface area within a mining domain or even for a single longwall panel is unlikely to be practical because of the high costs and other constraints that such an environment presents.

Sequencing

The concept of sequencing is to allow mining to occur in a semi-rural environment where subsidence and other impacts are tolerable before urban development commences. Thus the costs associated with managing subsidence impacts in an urban environment are avoided with overall benefit to the community.

If surface developments were concentrated in areas where subsidence has already occurred, there would be time for surface development to occur before it was necessary to develop other areas that have yet to be fully explored, mining plans developed and mining approvals secured. Once exploration is complete, it would also be easier to determine where main headings and other areas of low subsidence might be located so that surface development could more easily be placed in these areas.

Achieving a Balance

Within a 0-7 year timeframe, mining plans are typically well developed and exploration activities are generally complete or close to complete. The timeframes involved in gaining approval to mine are typically in the range 4-5 years so the mine plan tends to be fairly robust by then. A high degree of confidence can be placed in the mining layout and urban development can be staged or arranged accordingly. In a 0-7 year timeframe, there are identifiable benefits associated with delaying surface development until after mining subsidence has been completed. Newly constructed homes are not subject to mining subsidence. Larger commercial and industrial infrastructure can be built without potential for subsidence impacts. Coal can be mined without the potentially crippling costs associated with managing surface impacts in an urban environment.

In the 15 year plus timeframe, confidence that the mine plan will remain unchanged reduces because exploration activities are typically incomplete and various other factors can intervene to cause changes in the mine plan. Over this timeframe the costs of forestalling urban development become significant and the balance of overall community benefit is likely to tip in favour of allowing urban development to proceed at the risk of sterilising the coal resource.

Recognising that the high quality coking coal resource in New South Wales is a limited resource and this particular resource is close to the Port Kembla steelworks, a major industrial activity

that contributes significantly to the New South Wales and Illawarra economies, additional value may be given to protecting this particular resource. On the other hand, the granting of an approval to mine coal does not indefinitely preclude future development of the surface, particularly in areas where there is low potential for mining due, for instance, to geological structure, thin coal, or poor coal quality.

For timeframes between 7 and 15 years, there would be benefit in conducting a specific economic assessment that weighs up the benefits of the resource against the cost of forestalling urban development for the particular area in question. This assessment would be site specific and based on specific consultation with coal mining companies and with surface developers. It is possible that urban development could be prioritised into other areas or that mining activity and exploration could be prioritised to shorten the timeframe until the surface is available for development. Alternatively, it might be found that the presence of geological structure reduces the value of the resource and makes mining less attractive so that urban development is favoured over coal mining.

As noted above, the need for a framework for open and meaningful discussions between government, developers, and the relevant mining companies would seem essential if an optimum balance is to be achieved for the community as a whole. Options to fast track approvals to mine in areas that are subsequently earmarked for urban development may provide the option to expedite mining, allow subsidence to occur, and development to proceed in a timely fashion.

6.5 Coal Seam Gas Operations

Boreholes that supply coal seam gas are typically drilled in predominantly rural areas or areas remote from residential dwellings because of the legislation that removes the rights for exploration and other drilling activities:

- Within 200 m of a dwelling or house that is the principal place of residence of the person occupying it.
- Within 50 m of a garden.
- Or over any significant improvements.

Once drilled and completed, well head infrastructure is installed, and the well is connected to the network of low pressure gathering lines. Each site occupies a small footprint, a few tens of metres in each direction that is typically fenced. Locational guidelines provided by the NSW Department of Infrastructure, Planning and Natural Resources in 2004 recommend stand-off distances to residential development from operating gas wells of 5-10 m and for more sensitive infrastructure 8-20 m (NSW DPIPNR 2004).

As noted in the guidelines, these small stand-off distances may limit or preclude the ability to set up a drill rig over the hole for subsequent re-fracking, maintenance, or final sealing works if/when such works are necessary.

While individual well sites and the distribution network could ultimately be accommodated within urban developments with appropriate design, practical management of interaction between the earthworks associated with urban development and the gas drainage

infrastructure may present some practical challenges during construction of the development. Once in place, the wells and the gathering network appear likely to be able to co-exist with urban development during normal operations.

The challenges for co-existence appear to be mainly legislative ones should there be a need to re-occupy the hole. Operations that require for instance reinstatement of a drill rig during maintenance or final sealing of a well face the challenge of having no access rights “within 200 m of a dwelling or principal place of residence or 50 m of a garden or any significant improvements” as stated in the Petroleum (Onshore) Act 1991. This requirement has potential to impact significantly on the practicality of coal seam gas operations in an urban environment.

Furthermore, in October 2013, the NSW Government prohibited coal seam gas activity in existing residential zones in all LGAs in NSW and future residential growth areas in the North West and South West Growth Centres of Sydney via an amendment to the State Environment Planning Policy (Mining Petroleum Production and Extractive Industries) 2007 (the Mining SEPP). Coal seam gas exploration and extraction were also banned in 2 km buffers around these zones (NSW Government 2014, Strategic Regional Land Use Policy January 2014).

On the basis of these challenges, it would appear unlikely that coal seam gas operations could co-exist with urban development on any long term basis unless legislation is changed to allow greater certainty of access to existing wells.

6.6 Quarrying Operations

Quarry operations within the GMLRI extract sand and crushed sandstone for construction purposes. At present these quarries are located in semi-rural areas remote from urban development and are largely regulated by local councils rather than at a State level.

There are numerous examples in the Illawarra and elsewhere of quarries continuing to operate in close proximity to urban development, usually in areas where urban development has gradually encroached on existing quarrying operations. However, noise, dust, vibration, general loss of amenity, and sterilisation of available resource due to encroachment of urban development tend, over time, to put increasingly greater pressure on quarries to cease operations.

In general, the interaction of quarrying operations and urban development are considered likely to be able to be managed at a local government level. For state significant resources, the use of a buffer zone around quarries is likely to be an effective way to manage interaction with urban encroachment.

6.7 Legislative Controls

The legal framework to manage mining and other extractive industries is well established at a State Government level, although the framework does appear to have been relatively dynamic in recent times, particularly in relation to coal seam gas. Quarrying operations are generally controlled at a local government level. Federal regulation is limited to the Environment Protection and Biodiversity Conservation Act 1999 and impacts on water resources and flora, fauna, ecological communities, and heritage places.

SCT does not have expertise in mining legislation. The following section is prepared in response to a request in the review of the preliminary draft report for an overview of the legislation controlling mining and coal seam gas as context for how interaction with urban development may be controlled. This section is based on our general coal mining experience and a review of related websites.

The review of the legislation relating to mining and coal seam gas indicates that this legislation has become relatively dynamic in recent years, particularly in relation to coal seam gas.

General Planning

Federal legislation applies to mining related planning through the Environment Protection and Biodiversity Conservation Act 1999. This legislation is the Australian Government's central piece of environmental legislation. The legislation aims to provide a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places. The main impact this has on mining within the MRA is through the section that relates to water resource, in relation to coal seam gas development and large coal mining development.

Planning in NSW is largely governed by the Environmental Planning and Assessment Act 1979 (EP&A Act) and associated Regulations. These provide an overarching structure supported by other statutory documents. These supporting documents include the State Environmental Planning Policies (SEPPs), and Local Environmental Plans (LEPs).

The SEPPs outline the NSW Government's approach to dealing with planning issues of significance to the State and people of NSW. The provisions contained within SEPPs are integrated into legislation generally through amendments to the existing statutes.

There are a number of policies that are potentially applicable to mining and other extractive industries. These include:

State Environmental Planning Policy (State and Regional Development) 2011 that provides a framework to identify State significant development or State significant infrastructure and critical State significant infrastructure and to confer functions on joint regional planning panels to determine development applications.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 that provides for the proper management and development of mineral, petroleum and extractive material resources for the social and economic welfare of the State as well as appropriate planning controls to encourage ecologically sustainable development.

State Environmental Planning Policy No. 55 - Remediation of Land that provides planning controls for the remediation of contaminated land including actions prior to redevelopment.

Sydney Regional Environmental Plan - REP No. 9- Extractive Industry (No. 2) that identifies regionally significant extractive resources within the Sydney Region to facilitate their utilisation. This plan aims to ensure that extraction is carried out in an environmentally acceptable manner

and prohibits extraction from certain environmentally sensitive areas and that decisions on future urban expansion take into account the ability to realise the full potential of important deposits.

Each local government area has a LEP to guide development and protect natural resources such as waterways and heritage. LEPs are prepared by local Councils, in consultation with their community.

Beyond the SEPPs, local councils can administer more specific rules about land use through their Local Environmental Plans, and can provide additional guidance in their development control plans (DCPs).

Mine Specific Legislation

The EP&A Act 1979 establishes the development assessment and approval framework for exploration and mining activities. All new mining projects, and modifications to existing projects, require approval under the EP&A Act 1979 before they can commence. The Development Consent / Project Approval document usually includes other requirements such as Extraction Plan / Subsidence Management Plan for coal mining.

The mining lease/ petroleum production lease, together with other statutory approvals, such as environment protection licences under the Protection of the Environment Operations Act 1997 and planning approvals under the EP&A Act 1979 regulate the impact of mining on the environment.

Exploration

Before exploring for minerals or petroleum (coal seam gas) in NSW, an Exploration Licence (EL) under the Mining Act 1992 (and Regulation) or a Petroleum Exploration Licence (PEL) under the Petroleum (Onshore) Act 1991 (and Regulation) must first be obtained. An exploration licence gives the licence holder the exclusive right to explore for specific minerals or petroleum within a designated area, but does not permit mining, nor does it guarantee that a mining or production lease will be granted.

There are a range of activities that may be undertaken as part of an exploration program. Exploration generally starts from low impact activities and may progress to more intense and costly activities like drilling and bulk sampling. Intensive activities require an approval based on a Review of Environmental Factors (REF) including impacts to the community prior to starting.

Exploration licences are granted subject to standard and/or special conditions, including strict environmental management conditions to protect native vegetation, fauna, land, water resources, and heritage and community values.

Licence holders are also subject to a statutory prohibition on carrying out activities within 200 m of a residence without the consent of the land holder and resident. Licence holders are also required to rehabilitate areas disturbed by exploration activities. A security deposit to cover rehabilitation is a condition of licence.

A public comment process applies to exploration proposals for coal and petroleum (including coal seam gas). Community consultation is a condition of all exploration licences.

All new coal mines, petroleum production leases and mineral sand mines, other large mines and any mines in environmentally sensitive areas of State Significance are classified as State Significant Development and are subject to the EP&A Act 1979. These projects require assessment and approval before they can commence.

An application requires a comprehensive Environmental Impact Statement (EIS). The approval process for an EIS involves extensive public consultation and government agencies assessments.

Mining and Petroleum Production Leases

A mining lease gives the holder the exclusive right to mine for minerals over a specific area of land. In New South Wales, mining/ petroleum production leases are granted under the provisions of the Mining Act 1992 or Petroleum (Onshore) Act 1991. A mining/ petroleum production lease is a conditional authority. A development consent under the EP&A Act 1979 must also be in place before a mining lease, or petroleum production lease can be granted.

To be granted a lease, applicants must demonstrate that there is an economically mineable mineral deposit within the area of the proposed lease and they have the financial and technical resources to carry out mining in a responsible manner.

The costs to the leaseholder include: lease rental (based on land area), royalties (based on production levels) and a security deposit (based on rehabilitation liability).

Mining and Coal Seam Gas Operations

For coal, the Mining Act 1992 (and associated Regulation) controls environmental management of operations through the mining lease conditions. Instruments such as the Extraction Plan (EP), Subsidence Management Plan (SMP), Mining Operations Plan (MOP) of up to 7 years duration, and the Annual Environmental Management Report (AEMR) detailing environmental performance including rehabilitation provide the mechanism by which these conditions are applied.

The Work Health and Safety Act 2011 and the Work Health and Safety Regulation 2011 apply to all workplaces in NSW, including mining workplaces. Coal mine operational safety is largely regulated by the Work Health and Safety (Mines) Act 2013 and associated Regulations.

Compliance with any EPA Act 1979 approval conditions, other operating licences, mining lease conditions, environmental performance conditions, annual reporting, notices, and payment of lease rental, royalties and other levies entitles the lease holder to the rights under the lease for the duration of the grant, typically 25 years.

For the exploration and production of petroleum, in addition to the Petroleum (Onshore) Act 1991 (and associated Regulations), a Schedule of Onshore Petroleum Exploration and

Production Safety Requirements was published by the Department of Mineral Resources to manage health and safety requirements.

The NSW Gas Plan has effectively stopped all further coal seam gas developments (except those currently in production) in a pause, reset, and recommence strategy aimed to set a clear direction for gas exploration and production in NSW including a revision of the regulatory framework while delivering gas safely for the benefit of NSW citizens and businesses (NSW Government). In due course, it is expected that coal seam gas exploration and production will recommence.

Mine Subsidence Compensation

Compensation for mine subsidence is managed through the Mine Subsidence Board and the designation of Mine Subsidence Districts. The Governor may proclaim Mine Subsidence Districts in areas where there is likely to be potential for subsidence impacts. Within a mine subsidence district, integrated development requires approval from the Mine Subsidence Board under the Mine Subsidence Compensation Act 1961 to alter or erect improvements or to subdivide land.

Mine subsidence compensation is funded through a levy on operating coal mines. This levy can be varied to suit the requirements of the Mine Subsidence Board. Mine subsidence compensation applies specifically and almost exclusively to repair of physical damage to structures affected by mine subsidence. Compensation does not include consequential costs associated with loss of income, or measures taken to protect public safety. The cost of managing impacts other than repair to structures usually falls to the coal mining company causing the subsidence.

Community Consultation and Protection

Community protections are provided throughout the processes of granting exploration licences and mining or petroleum production leases and further protections are provided to individual dwellings.

Both the Mining Act 1992 and the Petroleum (Onshore) Act 1991 provide for community consultation before exploration licences are granted. The granting of Mining and Petroleum Production Leases and development consent under EPA Act 1979 also require a comprehensive stakeholder consultation and assessment process.

The Mining Act 1992 and the Petroleum (Onshore) Act 1991 include similar provisions within exploration authorities or mining/ production leases for access agreements, right of way, compensation and property protection.

Access arrangements are managed by agreement between the leaseholder and landholder (and resident) if possible or otherwise through an arbitrator. Easements and right of way may be arranged by right of title or by Minister's grant. There is provision for compensation for damage to such items as land, improvements or stock. Dwellings, gardens and significant improvements are protected through the mechanism that rights for exploration and other activities do not exist:

- Within 200 m of a dwelling or house that is the principal place of residence of the person occupying it.
- Within 50 m of a garden.
- Or over any significant improvements.

For coal seam gas related activities, further protections are provided in the SEPP (Mining, Petroleum Production and Extractive Industries) 2007. This SEPP sets out coal seam gas exclusion zones as well as a 2 km buffer zone around residential land and/or critical industry land in all LGA's. This provision does not apply to existing approvals or production leases.

Further protection is provided through standards for mining developments relating to noise, air quality, air blast, ground vibration, and groundwater.

Extractive Industries – Quarries

Under the EP&A Act 1979 (and associated Regulations), a quarry (extracting materials that are not defined as minerals under the Mining act 1992) may be approved for development by a lesser planning instrument (e.g. SEPP, LEP) if certain criteria are met regarding type of operation, size of operation, site properties including area, location, soil status, topography, impacts and proximity to other land users (residential and industry) and environmental impacts.

Under Sydney Regional Environmental Plan No. 9- Extractive Industry (No. 2) (deemed SEPP) certain areas have been identified current and potential construction material extraction areas of regional significance. These areas include material categorised as clay/shale sand, sand and gravel, hard rock, crushed sandstone and dimensional sandstone. Quarrying operations identified within the GMLRI are limited to sand and crushed sandstone.

Construction sand, soil, stone, gravel, rock or similar materials (which are not prescribed as minerals within the meaning of the Mining Act 1992) are defined as 'extractive materials'. A number of materials which may be regarded as extractive materials are not extractive materials for the purpose of this guideline (and Schedule 3 of the EP&A Regulation) as they are defined as minerals in the Mining Act.

An EIS must be prepared for developments which have the potential to significantly affect the environment. Under Part 4 of the EP&A Act 1979, extractive industries may require development consent under a local environmental plan or other planning instrument in which case Schedule 3 of the Environmental Planning and Assessment Regulation (EP&A Regulation) 1994 applies. Schedule 3 introduces thresholds based on the volume of material obtained, the area disturbed and the sensitivity of the affected environment.

Extractive industry in sensitive locations such as in or near water bodies, near the coastline, on steep land or close to residential land if blasting is undertaken are designated, and an EIS must be prepared. Certain types of extractive industry activities such as small scale maintenance dredging and extraction undertaken under an approved river care or river management plan are exempted from designation.

6.8 A Strategic Framework for Assessing Mining Values

Guiding Principles that Inform the Mining Framework

Coal Mining

- Underground coal mining and urban development can co-exist for residential development, most types of urban infrastructure, and some types of commercial and industrial development, but the proportion of the surface where development is present impacts on the degree of co-existence that is possible.
- Design and construction methodologies to accommodate subsidence impacts are well developed but some more significant structures may not be able to tolerate large subsidence movements.
- There is a mechanism in NSW to manage the costs of the rectification of damage to properties caused by mining subsidence through the Mine Subsidence Board. The Mine Subsidence Board do not cover losses to structures that are constructed after the declaration of Mine Subsidence Districts that do not meet the design requirements, the costs of maintaining public safety, or the costs of managing impacts to the natural environment.
- Once the proportion of residential development above underground coal mines increases above about 20-30% of the surface area, subsidence impacts become difficult to manage at a cost that is tolerable to the community and government and at a cost to mining companies that allows mining to remain viable.
- Mining would become non-viable for a lesser proportion of the surface area occupied by industrial, commercial, and large scale community development.
- Once mining is completed urban development can proceed at little additional cost apart from the need to manage impacts of ventilation shafts, mine pit tops, and coal haulage.
- Ideally, surface development would be sequenced so that it occurs in areas where mining has already been completed.
- Coal resources are most valuable where they are planned to be mined in the near future and this value diminishes thereafter due to the effects of time discounting and uncertainty around future mining plans.
- The relative value of mining development and potential urban development will depend on their likely timing and would require specific economic assessment.

Coal Seam Gas

- Conceptually individual well sites and the distribution network could be accommodated within urban development with appropriate design and a level of community acceptance.
- Current legislation limits the practicality of coexistence should there be a requirement for drill rig access for hole maintenance or final closure purposes.

Quarrying

- Quarry operations are generally located remote from urban development.
- Quarry operations can continue to operate in close proximity to urban development with appropriate buffers and conditions. However, urban encroachment can put increasing pressure on quarries to cease operations.

Framework for Determining Mining/Natural Resource Values

1. Identify exploration licences and titles
2. Identify coal seam gas infrastructure
3. Identify existing mining and quarrying operations and proposed timeframes for mining/extraction.

7 Tourism Values MRA

Tourism is associated with visitation by people from outside the study area. Recreation focuses on land and water based activities enjoyed by study area residents. Open space includes public protected areas as well private recreation. Scenic areas provide visitors and residents with pleasing rural vistas and can include public protected areas as well as private agriculture and bushland blocks. Often scenic areas include views from lookouts, scenic drives and the general amenity of a rural area.

7.1 Tourism and Recreation Overview

Destination NSW, the NSW Government's agency for tourism and major events, provides a visitor profile for Western Sydney that includes the LGAs of Auburn, Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Hawkesbury, Holroyd, Liverpool, Parramatta, Penrith, The Hills and Wollondilly. According to this profile Western Sydney attracted 276,000 international visitors, 2 million domestic overnight visitors and 6.9 million domestic day-trip visitors in 2014.

International visitors were drawn from New Zealand (19%), South Korea (11%), India (8%), China (7%), United Kingdom (6%) and United States (6%). International visitors spent approximately \$940 million. International visitors were most likely to be unaccompanied travellers in their mid-20s. The most popular activities for international visitors in Western Sydney were eating out in restaurants and cafes (82%), shopping (76%) and sightseeing (60%).

Most domestic overnight visitors to Western Sydney came from regional NSW, stayed an average of three nights and spent an estimated \$1.6 billion in 2014. The most popular activities for domestic overnight visitors were visiting friends and relatives (62%), eating out in restaurants and cafes (51%), shopping (25%), visiting pubs, clubs and discos (17%) and general sightseeing (14%). Most domestic overnight visitors were in the 30 to 44 years age bracket.

Domestic day trippers are most likely to live in the Sydney region. In 2014 they spent \$746 million in Western Sydney and visited the area to catch up with friends and relatives (40%), have a holiday (38%) and for business purposes (11%). Most were aged 60 years or older.

Table 7.1 summarises MRA tourism and recreational values.

Table 7.1 MRA Tourism and Recreation Values

	Western Sydney LGAs
Visitor Numbers	
International visitors (No.)	276,000
Domestic overnight visitors (No.)	2,000,000
Domestic day trip visitors (No.)	6,900,000
Visitor Expenditure	
International visitors (\$)	\$940 million
Domestic overnight visitors (\$)	\$1,600 million
Domestic day trip visitors (\$)	\$746 million
Total expenditure (\$)	\$3,286 million
Employment	
Accommodation (jobs)	2,461
Cafes, restaurants, pubs and clubs (jobs)	21,915
National parks, outdoor activities	1,356
Sport and recreation	5,194
Total employment (jobs)	30,926

Source: Destination NSW and ABS Industry by Employment LGA data

7.2 Slope and Scenic Values

Undeveloped ridgelines provide important scenic values in the MRA for tourists and residents.

Areas of high slope are unsuitable for urban development and have limited agricultural value. Areas of high slope (20°+) typically coincide with biodiversity 'hot spots'.

High slope scenic values may be preserved as open space due to low opportunity cost i.e. they are not suitable for urban and agricultural development.

7.3 Compatibility/Sequencing

Public open space used for tourism and recreation (e.g. the National Park estate) is protected and is not subject to competition from urban development. Private land enjoyed for its vistas may be lost to housing development. Land on ridgelines may be protected as it is not suitable for housing and agriculture. Private sector provided tourism sites zoned for urban development can still be utilised for tourism pending a decision to sell and active site development.

7.4 A Strategic Framework for Assessing Tourism Values

Guiding principles that inform the tourism framework

- The community places a value on both natural and built open space
- Values are derived from active (e.g. bushwalking) and passive (e.g. sightseeing) activities
- Tourism can be associated with specific sites as well as the general amenity and vista
- Ridgelines and areas of high slope create pleasing vistas and have low opportunity cost for development
- Significant tourism and recreation values are reserved in perpetuity in the public estate
- Heritage and any associated recreation and tourism values are protected and excised from urban development considerations
- If private land is of higher value as a tourism activity following rezoning, no land use change will occur.
- Rural villages are destinations for visitors, some of their attraction may be rural vistas and isolation from metropolitan areas
- Neighbouring districts may offer scenic drive and rural village alternatives.

Framework for Determining Tourism Values

- Identify tourism and recreation values on public and private land
- Identify any local recreation values with relevant Councils
- Consider scenic drives that may be vulnerable to urban development noting hills around rural villages and ridgelines of 200+ have low opportunity cost in urban development
- Document rural villages that may be destinations for visitors, noting that some of their attraction may be rural vistas and isolation from metropolitan areas

8 Other Values MRA

8.1 Fire and Flood Constraints

Flood Overview

The NSW Flood Prone Land Policy recognises that flood prone land is a valuable resource but aims to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property and reduce public and private losses resulting from floods (NSW Government 2005). While the policy recommends a merit based approach to all development decisions in the flood plain taking into account economic, social and ecological factors, as well as flooding considerations, flood planning levels for residential development are generally

based around 1% annual exceedance probability (AEP) flood events plus an appropriate free board (typically 0.5M) (NSW Government 2005).

Flood prone land e.g. a floodplain, can have high value for rural uses such as grazing, cropping and market gardens, although siting of infrastructure outside of the floodplain would generally be required.

Flood Compatibility/Sequencing

The 1% AEP flood zone provides a constraint on urban development.

Floodplains provide only a partial constraint on rural uses such as grazing, cropping and market gardens in terms of the siting of infrastructure.

Strategic Framework for Assessing Flood Issues

Action: Identify the 1% AEP flood zone – maps may be available from DP&E and Councils.

Bushfire Hazard Overview

Bushfires pose a threat to life and property. Planning aims to minimise these threats. A process exists in the NSW planning system where there is a requirement for the assessment of bushfire risk at the subdivision stage and for some developments at the building stage. This assessment is informed by bushfire prone land maps identifying vegetation within local government areas that has the potential to support a bushfire. The areas identified as bushfire prone changes with land clearing.

Bushfire Compatibility/Sequencing

Bushfire prone lands will to some extent coincide with vegetated lands.

Bush fire prone lands provide a partial constraint on urban development. Because urban development involves land clearing, this reduces the bushfire hazard. However, planning design for urban development will be impacted by the bush fire hazard of adjoining lands.

Strategic Framework for Assessing Bushfire Issues

Action: Identify bushfire prone lands.

8.2 Other Special Uses (e.g. Military Lands)

Australian Land Use and Management (ALUM) classification identifies a range of other special land uses. In the GMRA this includes Military Lands. Military Lands are considered an absolute constraint due to risks associated with unexploded ordnance.

Strategic Framework for Assessing Other Special Uses

Action: Identify and exclude special use lands that may provide a constraint to urban development.

8.3 Aboriginal Archaeology

Aboriginal cultural heritage consists of places and items that are of significance to Aboriginal people because of their traditions, observances, lore, customs, beliefs and history. It provides evidence of the lives and existence of Aboriginal people before European settlement through to the present. Aboriginal cultural heritage is dynamic and may comprise physical (tangible) or non-physical (intangible) elements. It includes things made and used in traditional societies, such as stone tools, art sites and ceremonial or burial grounds. It also includes more contemporary and/or historical elements such as old mission buildings, massacre sites and cemeteries. Tangible heritage is situated in a broader cultural landscape and needs to be considered in that context and in a holistic manner.

Cultural heritage is not confined to sites. It also relates to the connection and sense of belonging that people have with the landscape and each other as well as peoples' memories, storylines, ceremonies, language and 'ways of doing things' that continue to enrich local knowledge about the cultural landscape.

Aboriginal cultural heritage values are assessed from two perspectives, the values held by Aboriginal people i.e. Aboriginal heritage values, and scientific (archaeological) value i.e. the importance of a landscape, area, place or object because of its archaeological and/or other technical aspects (NPWS undated).

The *National Parks and Wildlife Act 1974 (NPW Act)* is the primary legislation for the protection of some aspects of Aboriginal cultural heritage in New South Wales. It provides specific protection for Aboriginal objects and declared Aboriginal places by establishing offences of harm unless harm is carried out under an Aboriginal Heritage Impact Permit (AHIP).

Compatibility/Sequencing

Aboriginal heritage conservation is not compatible with intensive rural or urban land uses.

Strategic Framework for Assessing Aboriginal Archaeology

Action: Identify sites of Aboriginal heritage significance.

8.4 Rural Towns / Villages and Rural Residential

Rural towns and villages may be scattered within MRAs. They provide both a constraint and opportunity to future land uses. They provide a constraint since they are already developed. They provide an opportunity because any future urban development can make use of underutilised land within or surrounding towns and villages. Rural towns and villages can also act as hubs within the detailed urban design of the area.

The MRA is peppered with existing rural residential lots. Rural residential lots are larger than a suburban house block and typically smaller than a hobby farm (40ha). Rural residential blocks fragment agricultural land and while their owners may keep a nominal number of livestock (e.g. pony and poultry) their existence is primarily predicated on a large family home rather than primary production.

Rural residential lots also provide a constraint on future urban development as they attract higher land values than larger agricultural holdings and they provide a barrier to consolidation for development given that they have multiple owners and land titles.

Compatibility/Sequencing

Rural towns and villages are a constraint on urban development as they are already developed.

Existing rural towns and villages need to be accounted for in the urban design of future urban areas.

Rural residential fragments the landscape reducing opportunity for commercial agriculture and urban development.

Strategic Framework for Assessing Rural Towns and Villages

Action: Identify location, profile and extent of existing rural towns and villages.

Map lot size and distribution of rural residential blocks.

9 Waste Management Issues MRA

9.1 Waste Management Overview

No matter where it occurs, population and economic growth results in the generation of waste. Once generated, waste is either recovered and recycled or joins the residual waste stream for disposal at landfill.

The location of recovery and recycling facilities is reasonably flexible and can generally be located within industrial zone land. Demand for new facilities can be allowed for within concept planning for new growth centres or be accommodated within existing appropriately zoned land.

Unlike other waste facilities, landfills are generally developed in existing excavated areas that are geo-technically suitable. Landfills are usually formed by quarrying and mining operations rather than identifying a site with unexcavated land. It is economically more efficient to fill existing excavations than it is to create new ones. The availability of landfill is therefore linked to the availability of suitable fill locations. Sites need to be accessible to waste transport trucks. However, beyond the distance that is viably serviced by collection vehicles, distance is not a

strong constraint. This is because of the low cost per tonne kilometre of transferring compacted waste in large trucks (Hyder 2009).

Almost all mixed residual putrescible waste (after recovery and recycling) generated in the municipal sector invariably goes to putrescible waste landfill in Sydney (Belrose, Lucas Heights, Eastern Creek and Jacks Gully) or to Woodlawn for disposal. In addition, nearly 40% of waste generated in the Construction and Industrial sector is collected as putrescible waste loads and is sent to putrescible waste landfills for disposal. A review of land fill capacity in 2009 (Wright Corporate Strategy Pty Ltd 2009) concluded that there is ample landfill capacity available for Sydney putrescible waste disposal extending for more than 20 years. Hyder (2009) found no evidence of any critical shortage of landfill capacity at any of the Australian population centres.

The Productivity Commission (2006) in response to concerns that Australia is running out of suitable space to use as landfills identified that typically, landfills have used old quarry or mine sites in or near urban areas, taking advantage of the underground voids already created and that generally speaking, Australia is creating new excavation sites faster than we are filling old excavation sites with waste. While the location of these sites, their geological suitability for landfill and concerns of many people about having a landfill in their 'backyard', can limit availability, the Commission considers that these issues are not insurmountable and can for the most part be addressed through the market and appropriate planning frameworks. To the extent that landfill space near an urban area becomes scarce, rising gate fees will make it financially worthwhile to transport the waste further afield, thus opening up the possibilities for new landfills.

Existing landfills provide a constraint on surrounding land uses due to requirements for noise and odour buffer zones. They also provide a constraint on future land uses once they are completed with open space generally the preferred use.

Proposed landfills to meet future demand also provide constraints on land uses.

9.2 Compatibility/Sequencing

Landfills are incompatible with other rural land uses and require buffer zones with adjoining land uses.

Post closure landfills are only suitable for limited land uses such as open space.

The location of other waste recovery and recycling facilities are flexible and can generally be located within industrial zone land.

9.3 A Strategic Framework for Assessing Waste Management Issues

Identify existing waste management facilities and landfills.

Identify if any land is earmarked as potentially suitable for landfills.

10 The Consolidated Framework

Analysis from Chapters 2 to 9 is consolidated in Table 10.1 for ease of reference and application to the GMLRI and other MRA areas.

Table 10.1 MRA Resource / Mining Framework

Objectives, Principles and Absolute Constraints	
Overarching objectives and principles	<p>Balance conservation, social and economic values consistent with 'A Plan for Growing Sydney'</p> <ul style="list-style-type: none"> • All land uses are associated with values to society. • Some of these values are mutually exclusive while others can be complementary. • The objective for land use allocation may be achieved via allocation of land to multiple land uses simultaneously, sequential land uses or a single land use. • Land use planning may involve trade-offs between values that are mutually exclusive. Where one land use displaces another, values from the displaced land use will be lost temporarily or permanently.
Identify absolute constraints	<p>Lands with absolute constraints whose use is restricted by legislation are assumed to include:</p> <ul style="list-style-type: none"> • Reserved lands under the NSW National Parks Act • Declared Wilderness Areas • Crown Reserves • Sydney Catchment Authority Lands • Existing biobanking sites • Defence Lands • Land zoned for Open Space under Council LEPs • Lands covered by SEPP 14 wetlands • State Forests • Cemeteries <p>Prepare study area maps that exclude these areas.</p>
Value/Issue	Actions Required
1. Biodiversity values	<ul style="list-style-type: none"> • Identify the presence of any threatened species, populations and ecological communities listed under the TSC Act and the Commonwealth EPBC Act that could potentially occur within the study area. • Identify conservation significance of biodiversity areas • Map biodiversity values.
2. Water quality issues	<ul style="list-style-type: none"> • Identify Restricted and Special Areas as absolute constraints. • Map streams and waterways that must be protected.
3. Air quality issues	<ul style="list-style-type: none"> • Identify local and regional air quality issues. • Compare study area air quality to other parts of the Sydney metropolitan area.
4. Agricultural values	<ul style="list-style-type: none"> • Develop an understanding of the agriculture 'big picture' including the presence of multiple supply chains, the importance of trade and an abundance of fresh food • Consult with Councils and interest groups and describe

	<p>additional values that stakeholders might attribute to study area agriculture</p> <ul style="list-style-type: none"> • Collate and assess objective data on agricultural values in the study area (ABS, ABARES, clusters, land capability) • Identify the value of potential agricultural production from the land • Map highest value agricultural land • Look for co-existence and sequencing opportunities for agriculture (i.e. low opportunity cost land)
5. Mining / natural resource values	<ul style="list-style-type: none"> • Identify exploration licences and titles • Identify coal seam gas infrastructure • Identify existing mining and quarrying operations and proposed timeframes for extraction
6. Tourism	<ul style="list-style-type: none"> • Identify tourism and recreation values on private and public land • Identify any local recreation values with relevant Councils • Consider scenic drives that may be vulnerable to urban development noting hills around rural villages and ridgelines of 20⁰+ have low opportunity cost in urban development • Document rural villages that may be destinations for visitors, noting that some of their attraction may be rural vistas and isolation from metropolitan areas
7. Other values - bushfire	<ul style="list-style-type: none"> • Map bushfire prone lands noting that the clearance of vegetation associated with urban development reduces bushfire hazard. Bushfire is a partial constraint and developments must comply with bushfire regulations
8. Other values - flood	<ul style="list-style-type: none"> • Identify the 1% AEP flood zone Map flood prone land.
9. Other values –special use land	<ul style="list-style-type: none"> • Use Australian Land Use and Management (ALUM) classification to identify other special land uses that may provide a constraint to urban development. • Map other special land uses (e.g. military lands)
10. Other values - Aboriginal archaeology and European heritage	<ul style="list-style-type: none"> • Identify sites of actual and potential Aboriginal heritage significance • Identify European heritage assets • Map heritage in the study area
11. Other values - Rural towns, villages and rural residential	<ul style="list-style-type: none"> • Identify location, profile and extent of existing rural towns and villages • Map lot size and distribution of rural residential blocks
12. Waste	<ul style="list-style-type: none"> • Identify existing waste management facilities and landfills • Identify if any land is earmarked as potentially suitable for landfills

11 Framework Application to the GMLRI

11.1 Definition of the GMLRI

The Greater Macarthur Land Release Investigation (GMLRI) area was defined by DP&E and project master planners Urbis as the 'urban capable' footprint – the boundaries of which are shown in Map 11.1 (below).

11.2 Biodiversity

The following areas have existing legal obligations for conservation management and are therefore not available for urban development and have not been considered further for biodiversity values:

1. Sydney Catchment Authority Special Areas
2. NPWS reserves
3. Existing Biobanking Sites

Map 11.1 shows land that is highly constrained from a biodiversity perspective. This is defined as:

- All native vegetation within the Priority Conservation Lands and Hawkesbury Nepean Corridors; and
- Any native vegetation that is:
 - EEC or CEEC outside of the PLC/HN and
 - is in A, B or C condition (NPWS, 2002); and
 - is a patch size greater than 10 ha.

11.3 Water Quality

Map 11.2 shows GMLRI waterways. Water NSW (previously the Sydney Catchment Authority) lands are outside the urban capable footprint. Urban development must have a sustainable neutral or beneficial effect on GMLRI water quality (NorBE).

Conditions that facilitate a sustainable neutral or beneficial effect on water quality (NorBE) are not uniform across the GMLRI. High slope areas ($>20^{\circ}$) need to be protected from some forms of development if NorBE cannot be demonstrated.

11.4 Air Quality

Further development in the Macarthur Region will contribute to local pollution issues and expose a greater number of people to high levels of ozone that originate locally and across the Sydney Basin. However, the Government already has a policy to develop the South West Growth Centre over a 25-30 year period to provide an estimated 110,000 dwellings. The additional number of dwellings in the GMLRI and hence additional population exposed to air pollution would be less than the South West Growth Centre.

Rather than air pollution issues being a constraint on urban development, local and regional policies in relation to industry, business, homes and motor vehicles are required to reduce pollutant levels in the face of increasing populations.

11.5 Agriculture

Map 11.3 shows agricultural land use in the GMLRI including the cluster of Poultry Sheds at Appin identified in APFGS 2014. Map 11.4 shows Land and Soil Capability within the GMLRI.

Relative to capability, substantial areas of better agricultural land are idle or underemployed in the GMLRI. Possible reasons for this include:

- A lack of agricultural profitability – production is simply not profitable on small and constrained GMLRI land holdings
- Land banking – it is easier for land owners speculating on rezoning to hold the land idle than to engage an agricultural tenant. Foregone income may be less than the cost of infrastructure repairs and maintenance (roads, water storages, fences, etc.).

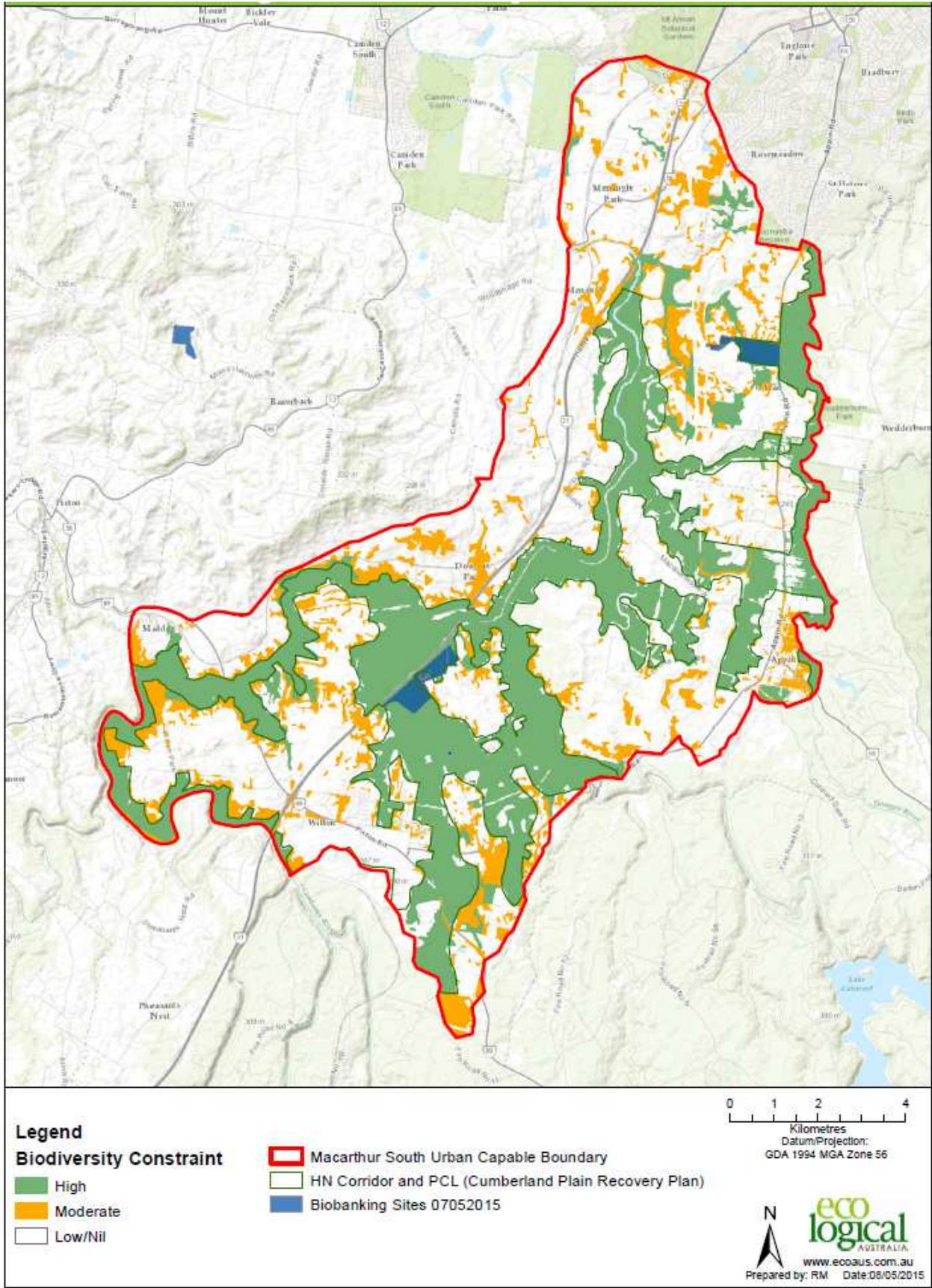
Application of the agriculture strategic framework to the GMLRI, including issues identified by SASA and others, reveals that:

- Class 1 and 2 land is the most important for agriculture
 - There is no Class 1 land in the GMLRI and Class 2 land totals 1,374 ha in a total project area of 15,966 ha (i.e. approximately 9% of the total project area)
 - Class 2 land has a potential value in agriculture (intensive vegetable production) of approximately NPV \$100,000/ha.
 - Class 2 land in the GMLRI is presently being used for grazing and the irrigation of modified pastures i.e. relatively low value uses rather than higher value intensive vegetable production.
- ABS data on Gross Value of Production (GVP), direct and indirect employment was used to identify higher value agricultural industries in the GMLRI. These industries include poultry, vegetables, ornamental horticulture and extensive grazing, their agricultural values in the GMLRI is as follows:
 - Poultry - APFGS 2014 agricultural Clusters 3 (see Map 11.3) includes poultry production. Poultry production is not dependent on land and soil capability. Poultry production requires buffers due to odour issues which can affect adjoining land holdings which can create conflict with adjoining land uses in some circumstances. Where zoning changes on poultry processing land or nearby, poultry producers who own or lease land can choose to remain in place after zoning changes are made if remaining in the GMRA maximises their utility/return on land investment. However, poultry producers typically move to greenfield sites demolish depreciated assets and realise land value gain (e.g. it is understood that Inghams Enterprises have applied to develop the Cluster 3

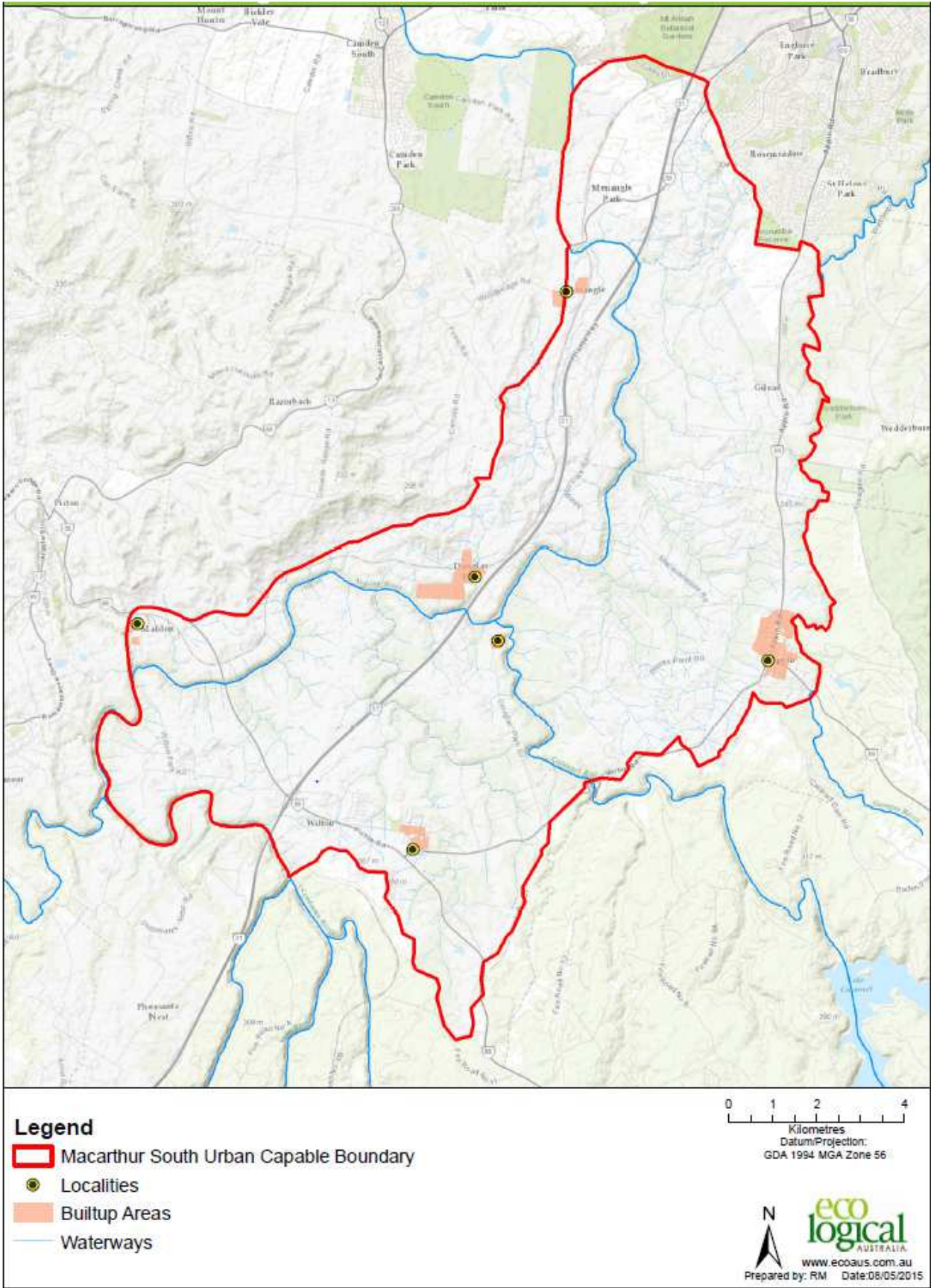
Appin site for housing). Other poultry producers have moved west of the Blue Mountains (proximity to grain supplies) or further south toward Goulburn (favourable highway access, processing capacity and lower cost land). A change in land zoning may see the industry relocate. Employment and some local jobs may be transferred out of the GMLRI with poultry industry relocation (i.e. they will be gained in other parts of the NSW economy). There is no resultant threat to food security/food production. Offsetting new jobs will be created in the GMLRI as a result of urban development.

- Vegetables – 5% of NSW’s vegetable production, by value, is grown in the Wollondilly and Campbelltown LGAs. There is a possibility that some consumers will perceive a health benefit from consuming local vegetables. However, there is very little vegetable production in the GMLRI – approximately 9 ha in total. There is limited flood prone land (i.e. land that is unsuitable for urban development) in the GMLRI that could be set aside for future vegetable production (see Map 11.10). Additional markets for fresh vegetables with buyers who are willing to pay more than current ruling prices would be required to stimulate vegetable production in the GMLRI. Ample fresh vegetables are available from other areas and the market is in equilibrium.
- Ornamental horticulture – dominated in the Wollondilly and Campbelltown LGAs by outdoor cut flower production. There is very little cut flower production in the GMLRI and production is included in the 9 ha estimate for vegetables. There is limited flood prone land in the GMLRI that could be set aside for future cut flower production (see Map 11.10).
- Extensive grazing – has a value of approximately NPV \$5,000/ha. Additional values in the Wollondilly and Campbelltown LGAs are associated with the pleasing agricultural vistas it creates. Ridgelines will be protected due to low value for urban development. Views from ‘touring’ roadways and historic town centres may be vulnerable to urban development.

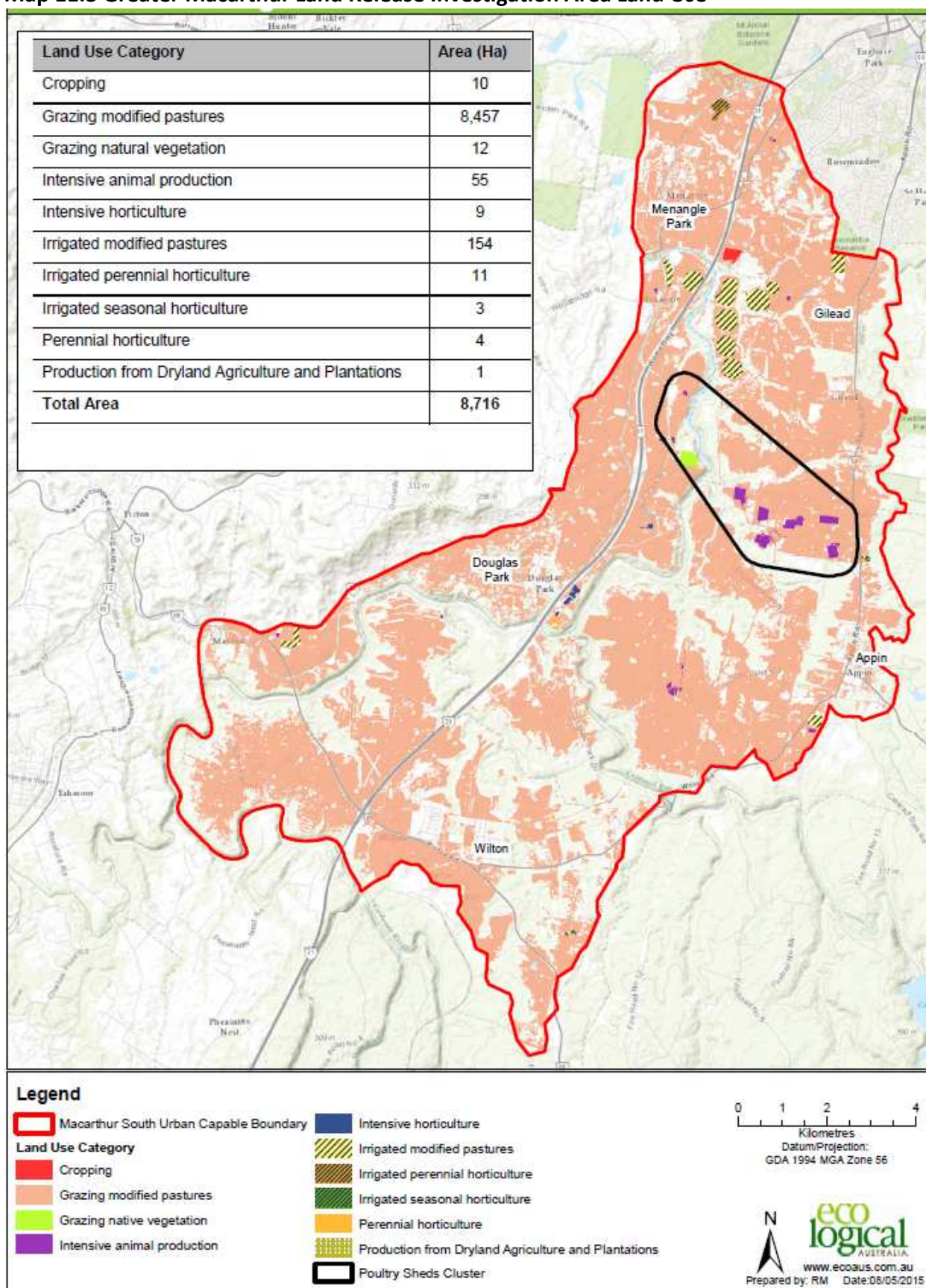
Map 11.1 Greater Macarthur Land Release Investigation Area Biodiversity



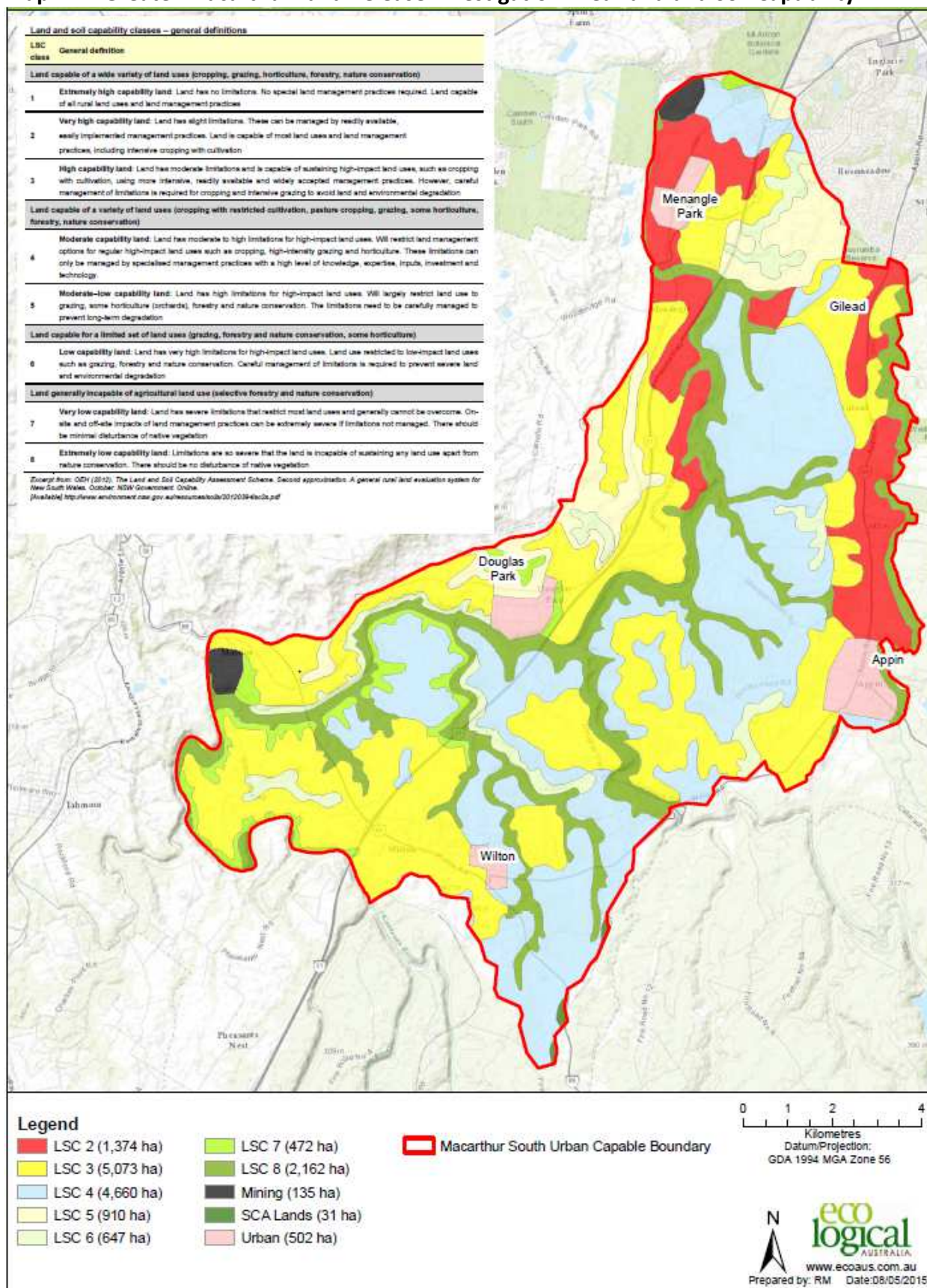
Map 11.2 Greater Macarthur Land Release Investigation Area Waterways



Map 11.3 Greater Macarthur Land Release Investigation Area Land Use



Map 11.4 Greater Macarthur Land Release Investigation Area Land and Soil Capability



11.6 Mining / Natural Resources

Within the GMLRI, there are large coal and coal seam gas resources currently being extracted. Sandstone construction materials are also being quarried.

Underground Coal Mining

The locations of the two active coal mines operating within the GMLRI are shown in Map 11.5. Appin Mine and West Cliff Colliery are owned and operated by Endeavour Coal Pty Ltd, a subsidiary of Illawarra Coal Holdings Pty Ltd (ICHPL), itself a wholly owned subsidiary of South32 Pty Ltd. Both mines are mature longwall mining operations with plans to merge into a single mine with two operating longwall faces and to continue mining for the next 25-30 years. Tahmoor Colliery owned by Glencore is located outside the GMLRI to the southwest.

Appin Colliery was established in 1962 and is the oldest of the ICHPL operating mines. Longwall mining was introduced at Appin in 1969 and has been ongoing ever since. Due to the high seam gas content and gas in adjacent coal seams a methane drainage system including a surface suction plant and pipe reticulation of the gas to the surface was introduced at Appin in 1981. Appin Mine now consists of the merged Appin and Tower Collieries. Tower Colliery (located at Douglas Park) commenced operation in 1978 and longwall mining commenced in 1988. Some 20 longwall panels were extracted up until September 2002. The underground infrastructure, roadways, conveyor and ventilation systems were joined in 2003 to Appin and the two mines were merged.

The mining lease for West Cliff Colliery was granted in 1969. Following development by Coal Cliff Collieries Limited, owned by CRA Limited, coal production commenced in October 1976 with longwall production commencing in 1982 and continuing up to the present. BHP Billiton purchased the mine in March 1997. West Cliff Colliery is planned to merge with Appin Mine once the current longwall area is complete with Appin Mine continuing as a two longwall face operation.

Both Appin Mine and West Cliff Colliery extract prime coking quality coal from the 2.0-3.5m thick Bulli Seam at depths below the surface predominantly in the range from 400-550m deep but increasing up to 850m in the west of Appin Mine in areas that are yet to be developed. Bulli Seam coal is used for steel making in Australia and exported through Port Kembla Coal Terminal to markets overseas.

The NSW Government granted approval for the Bulli Seam Operations Project (BSOP) in December 2011 with a projected annual production of approximately 9.3 Mtpa of product coal, primarily coking coal, over 30 years (to 2041). The BSOP is a 24 hour a day, seven days a week operation that is estimated to create 3300 jobs directly and indirectly for the region. The Bulli Seam Operations - Environmental Assessment (BSO-EA) assesses net production benefit at AUD 10.31b (PAC 2010).

Coal mining activity has been substantially completed over a large area in the centre of the GMLRI. The area of completed mining is increasing to the west and north as current mining activities in these areas continue. Even though subsidence movements associated with mining have been completed, some infrastructure within the area of completed mining remains

operational including ventilation shafts, the mine pit tops, and various gas drainage infrastructure.

Areas where mining in the Bulli Seam is complete have minimal mining values. Although significant coal resources remain in situ in the deeper seams the practical challenges to future mining presented by the presence of mining in the Bulli Seam make it unlikely these will become economic to extract in the future.

Mining Activity to 2019

The Mine Operations Plan (MOP) for the Bulli Seam Operations (ICHPL 2012) provides an indication of planned future operations at the mine. Map 11.5 shows the location of the various mining domains referred to in the MOP. The MOP describes mining activities over the seven year period from 1 October 2012 to 30 September 2019. Mining will generally be conducted in three mining domains; West Cliff, Appin Area 7 and Appin Area 9.

The MOP (ICHPL 2012) indicates:

Planned mining at West Cliff will progress in a northerly direction from the current longwall extraction panel through the next two adjacent panels. Extraction of these panels will be from west to east toward the Georges River. The final planned extraction panel at West Cliff will run north-south adjacent to the existing workings. At the completion of this panel, expected in mid 2016, the majority of the productive equipment will be relocated to Appin Area 9. All run of mine (ROM) coal from West Cliff is conveyed directly to the surface via a vertical shaft and processed at the West Cliff Coal Preparation Plant (WCCPP).

Current operations in Appin Area 7 will continue in a generally north west direction. The next two extraction panels (705 and 706) will be extracted from East to West as per current practise with the ROM coal being conveyed to the surface at Appin East and subsequently trucked to the WCCPP. The subsequent panels (707 onwards) will be extracted from West to East and the ROM coal will be conveyed underground through a new development roadway to the existing West Cliff shaft and hence directly to the WCCPP. There will be some facility to enable a portion of the ROM coal from Appin Area 7 to continue to be conveyed to the surface at Appin East.

Extraction from Appin Area 9 will commence after the completion of extraction at West Cliff, in mid 2016, and will occur concurrently with extraction in Appin Area 7. Mining will progress in a generally North West direction with all panels to be extracted from West to East. ROM coal from Appin Area 9 will be conveyed to the surface at Appin East and subsequently trucked to the WCCPP.

Areas where mining is proposed in the next seven years have the highest mining values.

Mining Activity Beyond 2019

The Bulli Seam Operations – Environmental Assessment (BSO-EA) describes the longer term plan for mining in the general area of the GMLRI. The longwall numbering indicates continued mining of Areas 7 and 9 to the north, a series of short longwall panels (LWs720-724) on the

southern side of the Nepean River, and then mining of Area 8 east to west along the northern side of the Nepean River and then west to east along the southern side of the Nepean River back towards Wilton. Mining in these areas has been approved.

Mining planned in Area 2, some of Area 3, and North Cliff was not approved as part of the BSO. As shown in Map 11.5, Area 2, most of Area 3, and North Cliff are located in catchment areas and conservation areas not suitable for urban development. The coal resources remain present in the ground and ICHPL may apply to mine in these areas in due course.

Other Coal Mining Activity

The Sydney Coal Basin extends in all directions away from the GMLRI continuing under Sydney through to Newcastle in the north, south to the Southern Highlands, and west to Lithgow. As well as the Bulli Seam, there are several other coal seams immediately below the Bulli Seam with commercial potential and it is possible that these may be targeted at some time in the future. Apart from the plans described above, there are currently no known plans for coal mining within the GMLRI.

Coal Seam Gas Projects

There are three gas projects operating within the GMLRI. AGL's Camden Gas Project, the largest of the three is located in the north of the GMLRI and extends outside the GMLRI further to the north and west. This project has been producing natural coal seam gas from boreholes since 2001. Energy Development Limited (EDL) runs two projects associated with Appin Mine and West Cliff Colliery that capture waste mine gas to produce electricity; the Appin and Tower Power Project began operation in 1996 and the WestVAMP Project began in 2007 (EDL 2015).

Petroleum Exploration Lease PEL2 owned by AGL covers all the GMIA and two Petroleum Production Leases PPL4 and PPL5 also owned by AGL cover the northern part of the GMLRI.

AGL Camden Gas Project

AGL's Camden Gas Project has been producing natural coal seam gas since 2001. It supplies around five percent of NSW's gas needs, providing families and businesses in Sydney with an energy source for cooking, heating, and water heating. The project includes 144 gas wells (96 currently producing gas), over 100km of low-pressure underground gas gathering lines, and the Rosalind Park Gas Plant (AGL 2014). At the Rosalind Park Gas Plant, natural gas collected via low pressure underground gathering lines from each of the wells is compressed, dried, and made ready for distribution through the local natural gas network.

Map 11.6 shows the location of the wells and network of underground, low pressure, polyethylene gas gathering pipes in relation to the GMLRI based on plans shown in the AGL Environmental Management Plan (AGL 2014). There have been no new wells drilled since September 2012. The low-pressure underground gas gathering lines are large diameter buried about 1m below the ground surface. Low water traps are installed in low lying areas of the gathering system to allow removal of water that may collect to ensure efficiency of the gathering system and these are emptied as required. Ancillary water transfer systems have been co-located in the gas gathering line trenches and installed simultaneously where required.

EDL Appin and Tower Gas Plant

EDL has collected waste coal mine gas (WCMG) from Appin and Tower Collieries to fuel its Appin and Tower Power Project since 1996 (EDL 2015). They are located adjacent to the ventilation shaft at Appin (near Appin township) and at the Tower Colliery pit top. The project produces 97MW of electricity.

EDL WestVAMP Project

EDL also operates the WestVAMP Project, developed in 2007 as a world-first power plant using methane in the ventilation air from West Cliff Colliery as the main fuel to power a 6MW steam turbine. The power station is located outside the GMIA near the West Cliff pit top but draws its gas from areas of West Cliff Colliery located below the GMIA.

Coal Seam Drainage Works

ICHPL undertakes progressive installation of gas drainage holes from the surface as part of ongoing coal mining operations. Surface to in-seam holes may be drilled in advance of mining to help reduce the volume of gas stored within the coal seam prior to mining. Goaf drainage holes may also be drilled in the goaf or just ahead of the active longwall panel to reduce the gas in the extracted areas reporting to the working areas underground. The captured gas may also be diverted into a network of surface pipes for use in power generation or simply flared.

Abandoned Coal Mine Gas Drainage

Once the coal mines have been abandoned, there is potential for coal seam gas to build up in the mine and in the fracture networks created within and above the mining horizon by mining activity. There are currently no abandoned mines within the GMLRI, but once mining is completed at Appin and West Cliff, there will be potential for gas drainage from these mines to provide a significant gas resource that can be accessed without the need for a large number of boreholes (wells).

Quarries

Known quarries within the GMLRI include a crushed sandstone and sand quarry located adjacent to the Hume Highway near Menangle as shown on Map 11.7. The crushed sandstone quarry is referenced in NSW Government (2015) as Schedule 1, Division 8, 3 Medhurst Road, Menangle Park. Further work is required to fully investigate the extent, nature, and life of these quarrying operations. No other active quarries are recognised as being located within the GMLRI.

There are also a number of disused quarry sites within the GMLRI and a coal reject emplacement site at Glen Lee that is just on the northern fringe of the study area.

The Regional Environmental Plan No. 9 – Extractive Industry No. 2 – 1995-574 (NSW Government 2015) identifies quarries in a broader area that includes the north of the GMLRI as regionally significant.

Assessment of Coal Mining and Coal Seam Gas on Urban Development Potential

Map 11.8 shows the various levels of potential interaction between urban development and mining, including the location of areas where coal mining has already been completed, areas

where coal mining is planned in the immediate future (0-7 years), areas where coal mining is planned in the 7-15 year timeframe and in the 15-30 year timeframe, and areas where there is coal resource available to mine but even conceptual plans have yet to be developed and/or approved.

There are significant areas of the GMLRI currently available for urban development where subsidence is already completed or there are no current plans before government for future coal mining. In these areas, there would not appear to be any potential for conflict between coal mining and urban development other than existing surface infrastructure associated with mining. Most of the Appin West area and slightly less than half the Wilton Junction area are free from conflict with mining. A staged approach for urban development involving surface development of these already subsided areas first with development of remaining areas in due course would be optimum.

Areas where there is likely to be an overall community benefit if mining and other resource activities are given priority over urban development (0-7 years) have also been identified. There are clear plans to mine in these areas and urban development would ideally be forestalled in these areas to avoid the possibility of subsidence impacts when a short delay in development would obviate any potential for impact.

Areas where mining is not planned for 7-15 years may warrant further investigation and economic evaluation on a case by case basis. Plans for mining are fairly well advanced, but the cost of forestalling surface development for 15 years may start to exceed the value of the coal resource. These areas are determined on the basis that mine plans for 7-15 years are foreshadowed but may nevertheless be subject to some change in footprint that would affect where surface infrastructure sensitive to mining subsidence such as hospitals and large commercial and industrial structures might be located to limit surface impacts without otherwise impacting mining layouts.

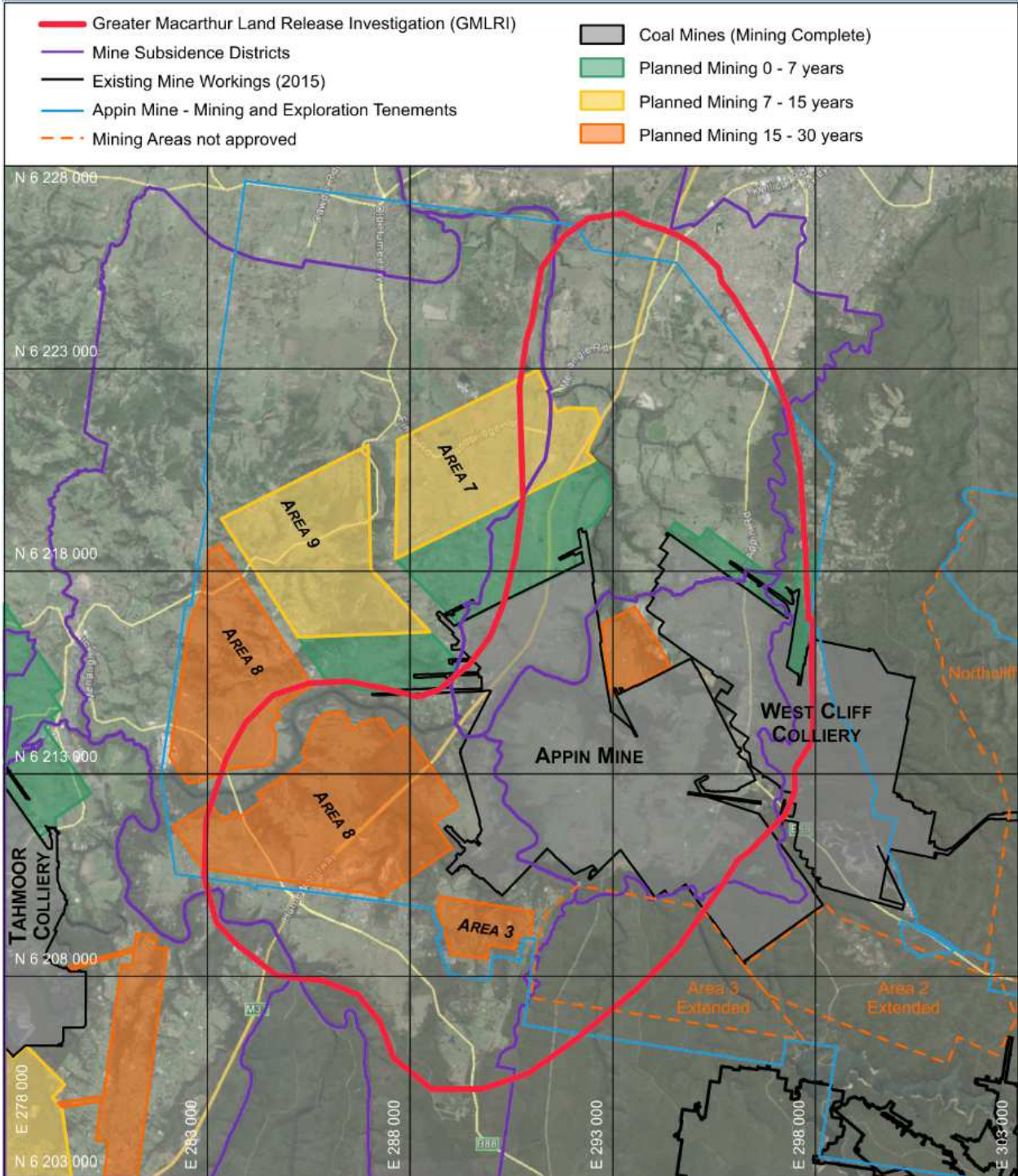
Areas where mining is not planned for 15-30 years are still somewhat tentative because exploration activities are incomplete and there is a high probability that mining geometries will change over this period. The areas identified as having potential for mining beyond 15 years are recognised as being possible sites for mining but with uncertainty about the actual mining layout and in some cases the marginal viability of particular areas, the argument to forestall urban development in order that mining may or may not proceed becomes less convincing. There may be options within these areas to prioritise mining into a shorter timeframe to suit surface development but such options require discussion between coal mining companies the government, the Mine Subsidence Board, and developers and are beyond the scope of this report.

Coal seam gas operations appear able to co-exist with urban development, at least until there is a need for a drill rig to occupy the site for say maintenance or closing down the well. A change in legislation in relation to access rights in an urban environment may be required to overcome this issue. Without such a change, long term co-existence and certainly the development of new wells seems likely to be precluded so that the pressures of urban development over time would cause the closure of ongoing coal seam gas operations with the loss of a valuable resource.

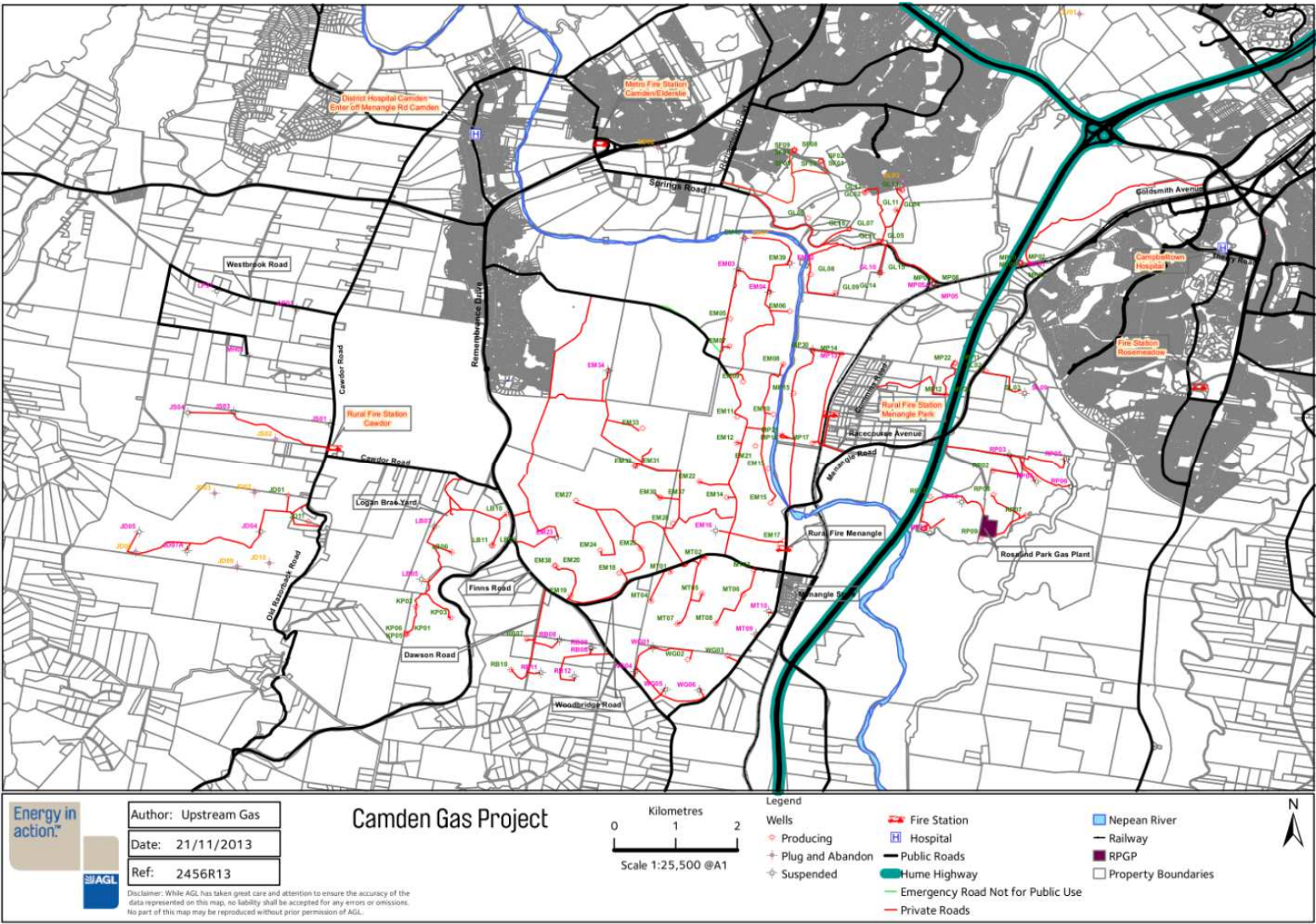
Future access to coal seam gas from abandoned underground coal mines would be similarly affected mainly through gradual diminution of sites suitable to locate gas drainage wells.

It is considered that quarry operations can be managed at a local government level through the provision of buffer zones to areas of significant resource. Further assessment of individual quarry operations was not able to be conducted as part of this study.

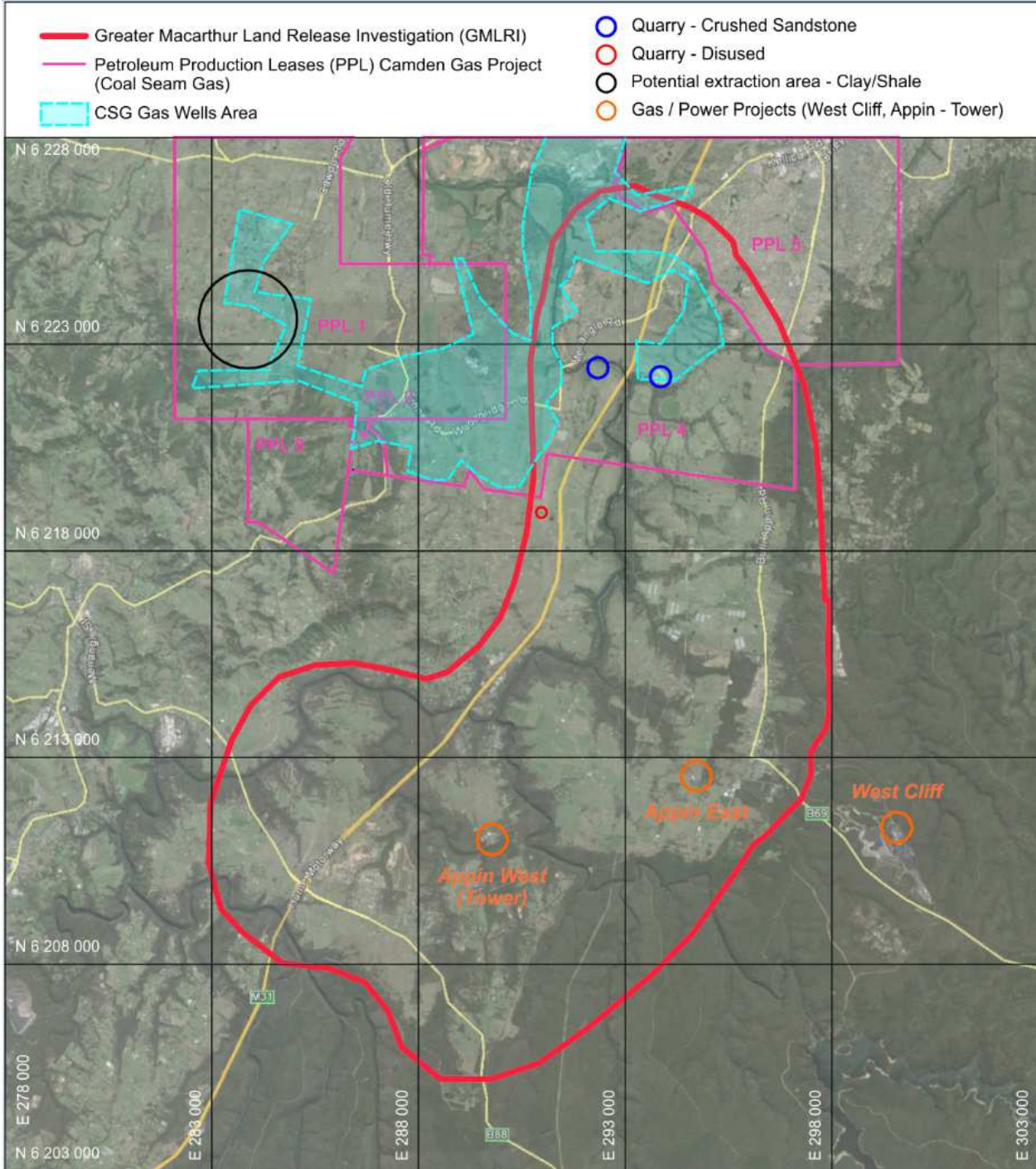
Map 11.5 Location of Coal Mines in the GMLRI



Map 11.6 Coal Seam Gas Wells and Gathering Pipe Network (from AGL 2014)



Map 11.7 Coal Seam Gas and Quarry Operations



The map displays the Appin Mine area with various mining and exploration tenements. The legend indicates the following categories:

- Greater Macarthur Land Release Investigation (GMLRI) (Red line)
- Existing Mine Workings (2015) (Black line)
- Appin Mine - Mining and Exploration Tenements (Blue line)
- Possible Future Mining (Dashed orange line)
- No Current Plans for Mining (Pink outline)
- Mining Complete (Grey area)
- Planned Mining 0 - 7 years (Green area)
- Planned Mining 7 - 15 years (Yellow area)
- Planned Mining 15 - 30 years (Orange area)

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- Mining Complete (Grey area)
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- Planned Mining 7 - 15 years (Yellow area)
- Planned Mining 15 - 30 years (Orange area)

11.7 Tourism

Campbelltown Section of GMLRI Sub-region

- Tourism activity in the study area includes harness racing facility at Menangle Park.
- The area is rich in Aboriginal artefacts. European heritage includes Beulah House and the Mt Gilead Homestead and Mill. Developer plans include proposals to protect and preserve amenity associated with these early settlement assets
- Swimming holes in both the Georges River (e.g. Wool Wash) and Nepean River (e.g. Simmo's Beach) are popular with locals. Water quality is good and measures are in place to ensure its ongoing protection.

Wollondilly Section of GMLRI Sub-region

- Tourism assets in the Wollondilly section of the GMLRI include the parachuting centre which may employ up to ten people. The centre is part of a bigger operation based out of Bankstown Airport and has indicated a long term interest in relocating out of the study area and realising increased land values.
- The study area includes long river reaches used for swimming and fishing as well as private land that is used for horse riding.

The vast majority of tourism destinations in the GMLRI are located on land protected for that purpose (e.g. lands protected under the NSW National Parks Act). These protected lands are well placed to provide these forms of outdoor recreational opportunity in the future.

Urban pressure may displace tourism activities on private lands. However, it needs to be noted that values created in the study area are not unique to the GMLRI and are replicated in other places including the Southern Highlands and Southern Tablelands.

Scenic values that are unique in the GMLRI and on private land are by default protected under current controls (e.g. EMAI).

The analysis has shown:

- Nothing on public protected lands used for tourism is subject to urban pressure –these areas are an absolute constraint and were excised from the study area prior to commencement
- Nothing on private lands (e.g. parachuting centre, paintball, etc.) is forced to close as a result of urban pressure – these lands can still be used indefinitely for tourism if this decision maximises the owners welfare
- Popular routes / country drives used by touring groups (e.g. vintage car enthusiasts) that might be protected from urban pressure, would be protected at considerable opportunity cost. Country drives are replicated in other areas.
- Unique tourism values associated with any private land are already protected in legislation. Other tourism values on private land are replicated in other areas.

11.8 Other Values

Bushfire Prone Lands

Land potentially affected by bushfire in the GMLRI is shown in Map 11.9. The main bushfire threat is from the southwest and west. The last major fire in this area was in 2000. Urban development on bushfire prone land is comprehensively managed under the relevant NSW Bushfire Regulations.

Flood Constraints

Land potentially flood prone i.e. subject to the one in one hundred year inundation event is shown in Map 11.10. GHD (2015) note that the extent of the one in one hundred year flood is generally confined within the incised watercourses and within the relatively steep vegetated lands along the watercourse where development would be unlikely to proceed irrespective of flooding conditions.

Other Special Uses (e.g. Military Lands)

Military lands have already been excluded from the study area. No other special use land has been identified.

Aboriginal Archaeology

A total of 253 previously registered Aboriginal sites were identified in the GMLRI. See Map 11.11.

In addition, six areas with specific cultural values to the Aboriginal community were identified:

1. Rocky Pond Creek massacre/burial - an area southwest of Appin, east of Douglas Park Drive near Cataract River was the site of a historical massacre. The site is also documented in the AIMS database
2. Hanging tree associated with Rocky Pond Creek massacre/burial to the east of the burial where Aboriginal people were hanged following the massacre event
3. Fishing and story place - a stretch of the Nepean River, east of Menangle near Birdseye Corner, that is known to have good fish and eels, and been extensively used by Aboriginal people in the recent past and continues to be used today. Within this stretch is an important Story Place
4. Historic building owned by BHP - a structure just north of Douglas Park, which is known to contain holes in the walls through which Aboriginal people were shot in the past
5. Barrigal Lagoon - a stretch of the Nepean River, west of Menangle, that was known to have good fish and eels, and been extensively used by Aboriginal people in the recent past. Activities nearby also included meetings and dancing, along with day-to-day subsistence

6. Canoe tree - a tree with large culturally created scar is known in the northern quadrant.

A predictive model identified where archaeological resources are likely to survive. Areas with a high likelihood of archaeological resources and areas of specific cultural significance are identified in Map 11.11.

European Heritage

A search of historic heritage lists identified thirteen sites on the Register of National Estate, approximately 50 on the State Heritage Inventory (and duplicated on the Local Environment Plans and Section 170 registers), and 33 sites on the National Trust of Australia. Of note, for the purposes of future planning are eight sites listed on the State Heritage Register (Table 11.1 and Map 11.11). These listings focus on rural places such as Beulah, Glenlee, Sugarloaf Farm, Camden Park but also include the late 19th Century Upper Canal System (Pheasants Nest Weir to Prospect Reservoir) and the Menangle Railway Station Group and the Menangle Rail Bridge. These listing are afforded the highest level of protection in NSW, and would constrain or inhibit any development within or in close proximity to their curtilages. Historic heritage sites are identified in Map 11.11.

Table 11.1 – State Heritage Register Items within the Study Area

Name of Item	Group/Collection	Primary Address	LGA	Item #
Glenlee; outbuildings, garden and gate lodge	Farming and grazing	Glenlee Road, Menangle Park, NSW 2563	Campbelltown	00009
Sugarloaf Farm (Mt Huon)	Farming and grazing	Menangle Road, Gilead, NSW 2560	Campbelltown	01389
Beulah	Landscape cultural	767 Appin Road, Gilead, NSW 2560	Campbelltown	00540
Camden Park Estate and Belgenny Farm	Farming and grazing	Elizabeth Macarthur Avenue, Camden South, NSW 2568	Camden	01697
Menangle Rail Bridge of Nepean River	Transport - Rail	Main Southern Railway, Menangle, Gilead, NSW 2571	Wollondilly	01047
Menangle Railway Station group	Transport - Rail	Main Southern Railway, Menangle, NSW 2571	Wollondilly	01191
Windmill Hill Group, including Ruins (other names: North Farm, Middle Farm aka Larkin Farm and Windmill Hill, South Farm, Steven's Homestead	Farming and grazing	Wilton Road, Appin, NSW 2560	Wollondilly	01931
Wilton Park	Farming and grazing	Wilton Park Road, Wilton, NSW 2571	Wollondilly	00257

Rural Towns, Villages and Rural Residential

Rural towns, villages and rural residential communities Wollondilly and Campbelltown LGAs which fall within the GMLRI unconstrained area are shown in Map 11.12 and reviewed in Tables 11.2 and 11.3 below.

Table 11.2 Rural Towns, Villages and Rural Residential Communities GMLRI – Wollondilly LGA

Centre	Attributes
Appin	<ul style="list-style-type: none"> Population of 1,756 Located 76 Km from Sydney and 35 km from Wollongong. Employment is dominated by the nearby colliery. Social assets include a public school, a mobile library, play groups, pre-school, community hall, two sportsgrounds, and a bushfire brigade.

Douglas Park	<ul style="list-style-type: none"> • Population of 1,273 • Located 80 Km south west of Sydney • Social assets include a post office, general store, service station, café, sports ground, public school and rural fire service.
Maldon	<ul style="list-style-type: none"> • Population of 152, Maldon is best known as an industrial area that is well serviced by the Hume Highway. Key industries include the Boral Cement Factory and Allied Mills Flour Mill. • Maldon Gorge is a popular picnicking, bushwalking and swimming spot
Menangle	<ul style="list-style-type: none"> • Population of 877 • Located 60km from Sydney • Village features many historical buildings including the now closed public school
Menangle Park	<ul style="list-style-type: none"> • Population of 241 • Located 56 km south west of Sydney • Includes harness racing track and historical buildings. The village includes a small general store, a rural fire brigade shed and a tavern.
Wilton	<ul style="list-style-type: none"> • Population of 1,279 including the new estate of Bingara Gorge. • Located 80km south of Sydney and 30km north of Wollongong • Previously proposed as a second airport site. The urban area currently includes a school, various take-aways and a petrol station. • Wilton is a rowing village providing housing for those employed in mining and an additional 1,000 houses are proposed • <u>Status</u>: proposed for further urban development

Wollondilly Council's Growth Management Strategy 2011 plans for

(<http://www.wollondilly.nsw.gov.au/planning-wollondillycd/strategic-planning-wollondilly/1161026-wollondilly-growth-management-strategy-gms>):

- 'Natural' growth of 1.9% pa which mean a 20,000 population increase in the next 25 years.
- Not having further major urban releases within the Macarthur South area at this stage.
- Planning for the delivery of at least 7,500 new houses over the next 25 years.
- Planning for a range of different housing types to meet the needs of the future community.
- Planning for a range of new employment opportunities.
- Ensuring all forms of growth are compatible with the vision of 'rural living'.
- Acknowledging and seeking to protect the Shire's rural and resource lands because of their special economic, environmental and cultural values.
- Encouraging sustainable growth which supports our existing towns and villages, and makes the provision of services and infrastructure more efficient and viable.
- Planning for the majority of new housing growth to be focused within or immediately adjacent to existing settlements, rather than spreading it through the rural areas.

Table 11.3 Rural Towns, Villages, Rural Residential Communities GMLRI – Campbelltown LGA

Centre	Attributes
Gilead	<ul style="list-style-type: none"> • Population of 349, 58 km south west of Sydney • Proposed for additional housing development • Proposal is for low density residential development supported by public open space and community facilities, including a small retail centre • Protect environmentally sensitive land and provide an environmental bushland corridor that links the Noorumba Reserve with the Beulah biobanking site and the Nepean River corridor • Respect the heritage significance of the Mount Gilead homestead site including the outbuildings, mill and dam and their setting • Respect the environmental significance of the Beulah biobanking site • Reserve land for acquisition by Roads and Maritime Services for future road infrastructure (widening of Appin Road). • Increase the supply of housing within the Campbelltown LGA with the addition of up to 1700 new dwellings

It is important to note that the status of Planning Proposals is different in each of the LGA areas in the GMLRI. Campbelltown is progressing Planning Proposal considerations while Wollondilly has resolved to hold Planning Proposals until an outcome from the Greater Macarthur process is known. Certainly Picton, Wilton and Tahmoor are identified for growth and this will modify their current rural town status. Only Wilton falls within GMLRI boundaries.

The financial viability of urban development can be impacted by the size of rural land parcels with larger parcels able to be developed more easily. To provide an indicator of land fragmentation in the GMLRI, property sizes have been mapped (Map 11.13) as:

- <40ha
- 40 ha to 100ha
- > 100 ha

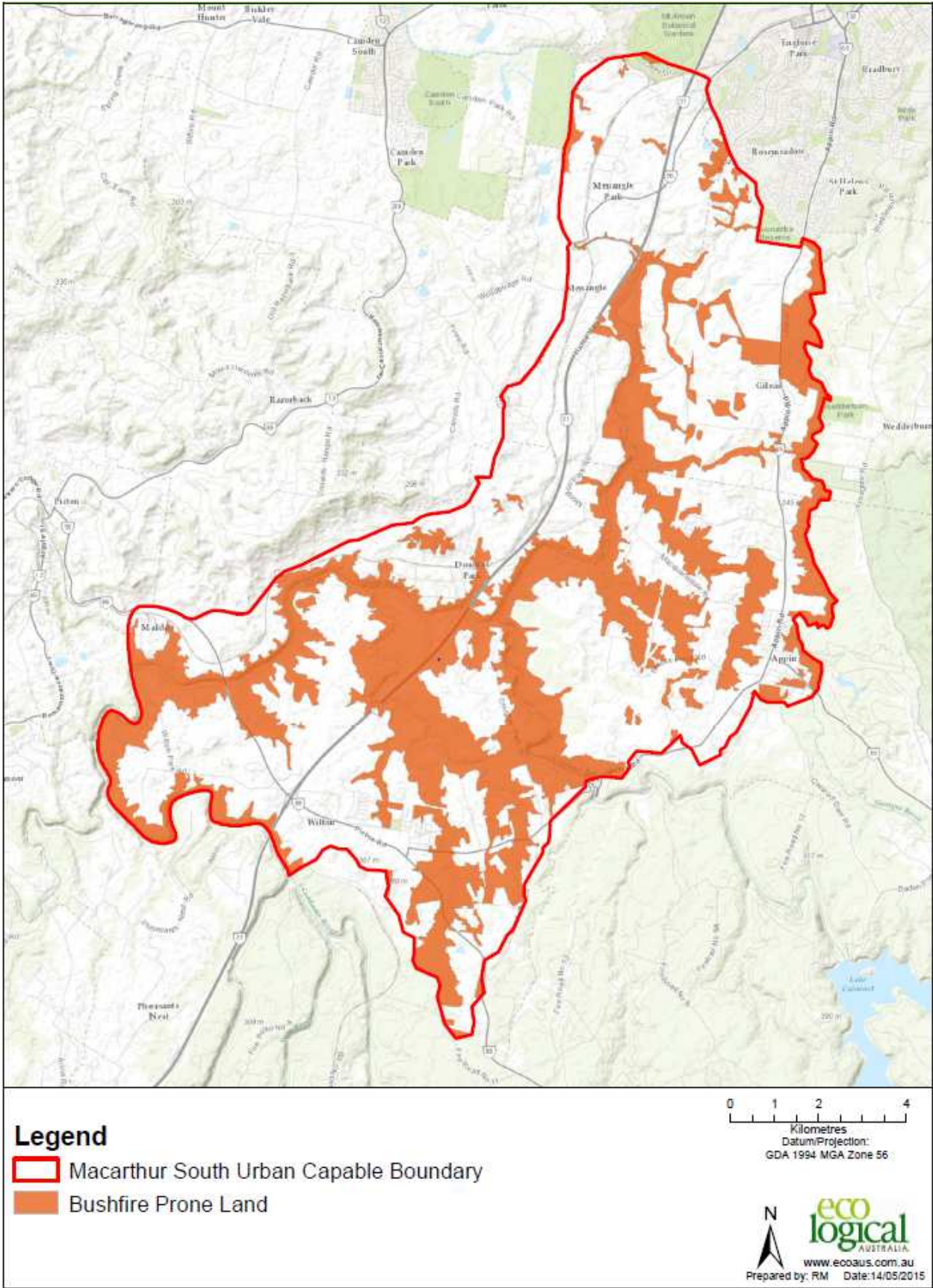
From Map 11.13 it can be seen that the study area is highly fragmented and dominated by holdings less than 40 ha.

11.9 Waste

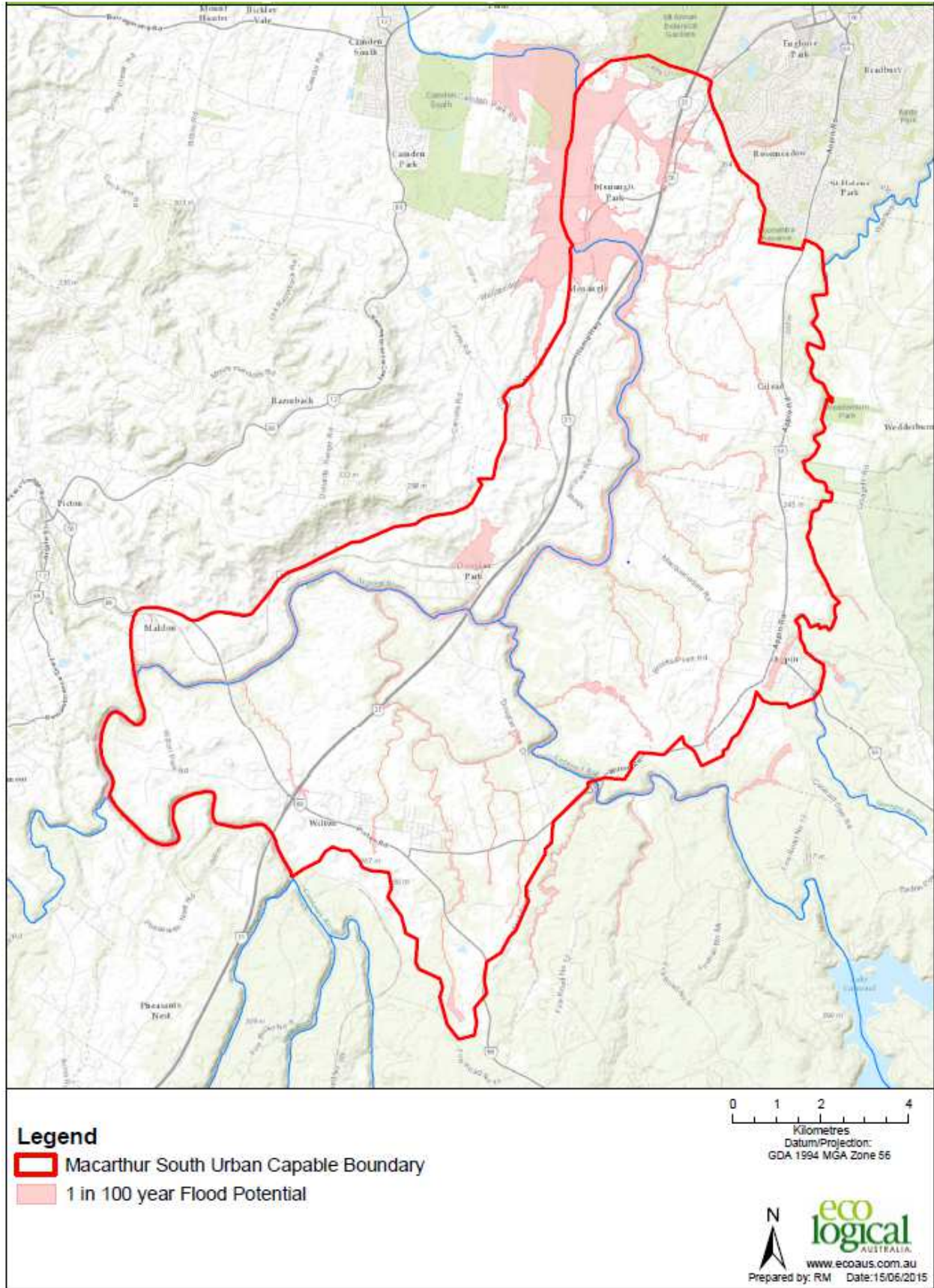
There are no landfills located in the GMLRI or any plans for a future landfill.

Development of the GMLRI would generate additional waste, some of which would require landfill. However, for the purpose of the analysis underlying population growth can be considered a given and regardless of where it is accommodated the same level of waste will be generated and require disposal in the same network of landfills.

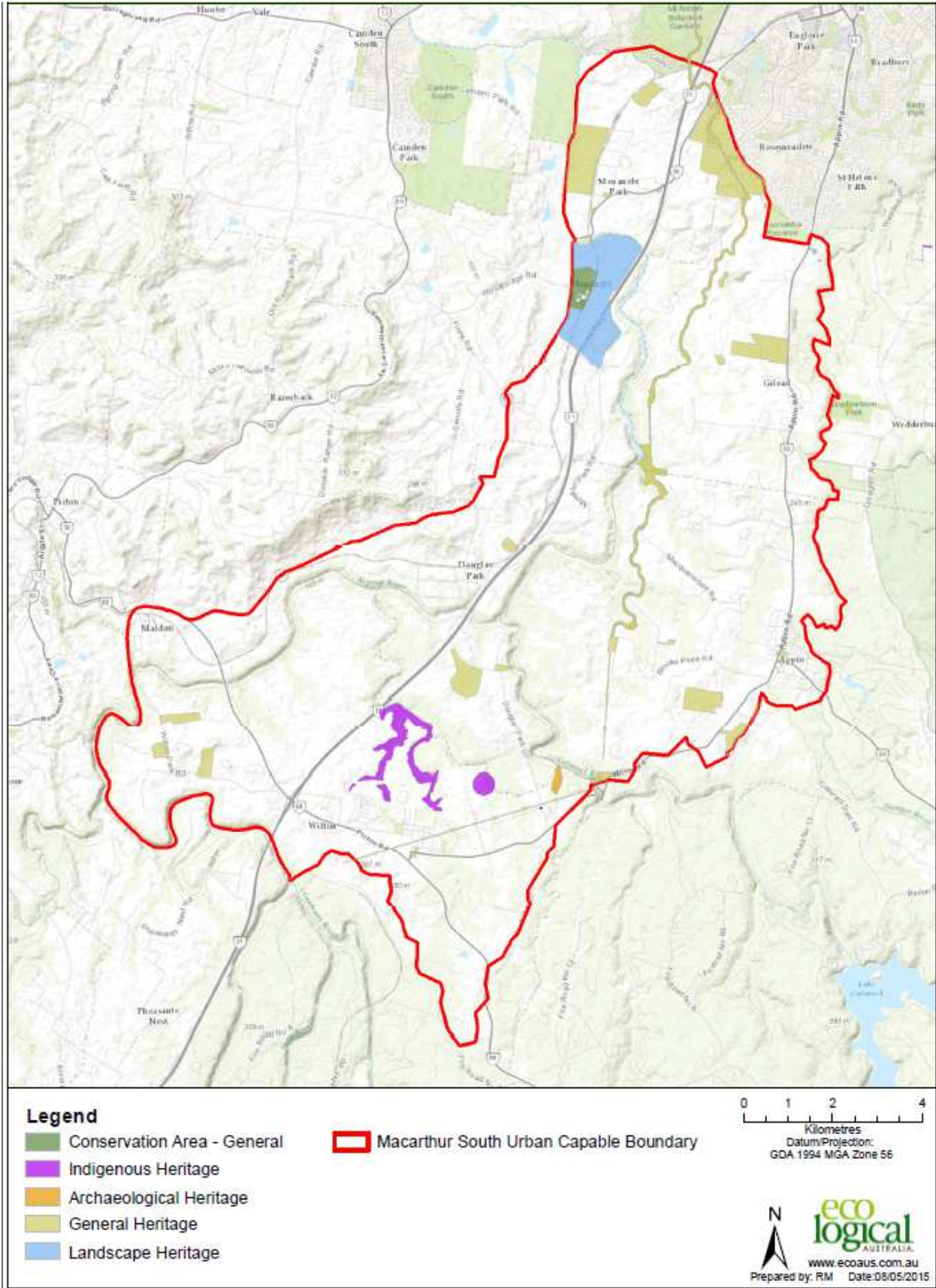
Map 11.9 Greater Macarthur Land Release Investigation Area Fire Prone Land



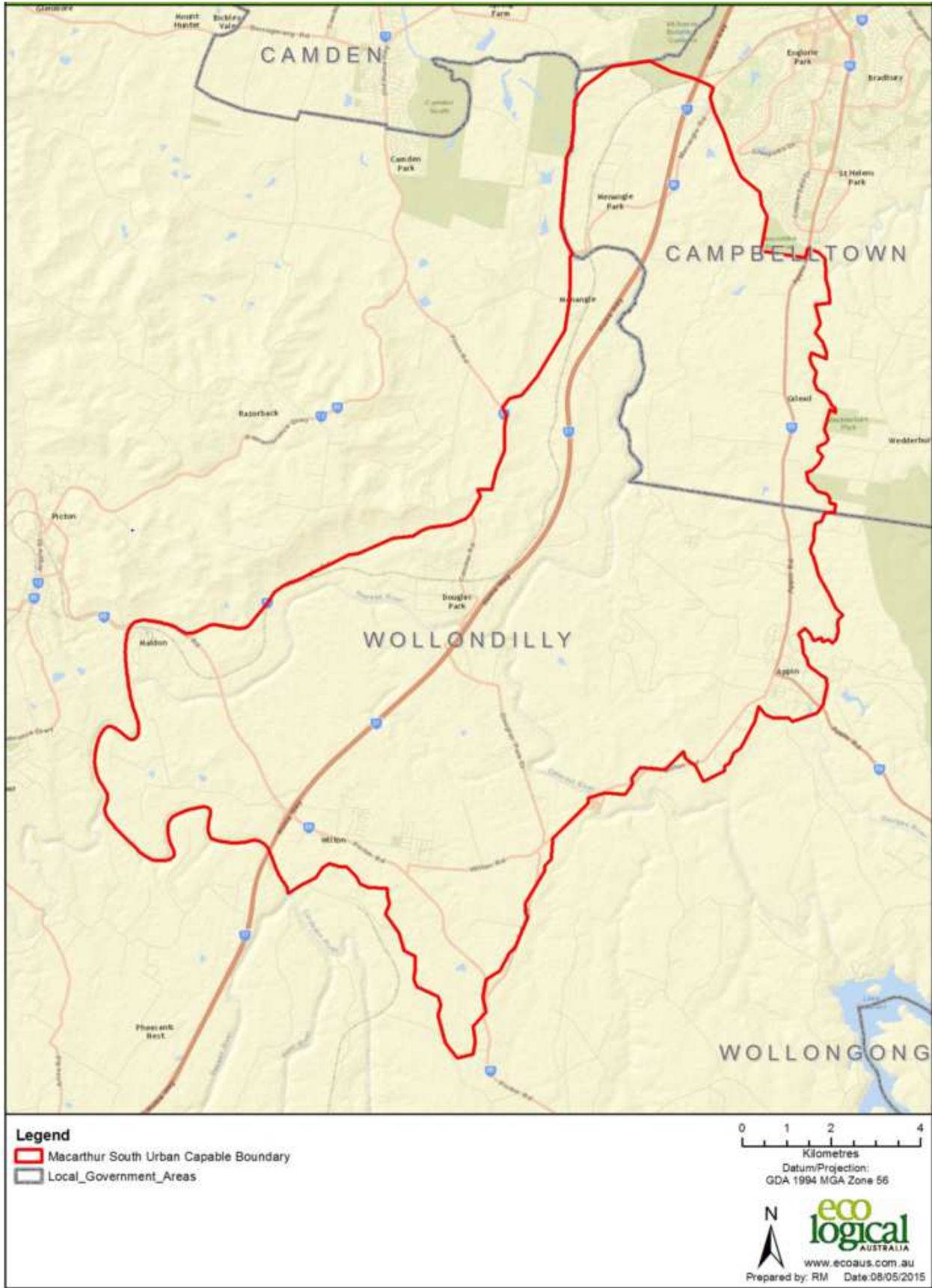
Map 11.10 Greater Macarthur Land Release Investigation Area – 1 in 100 Year Flood



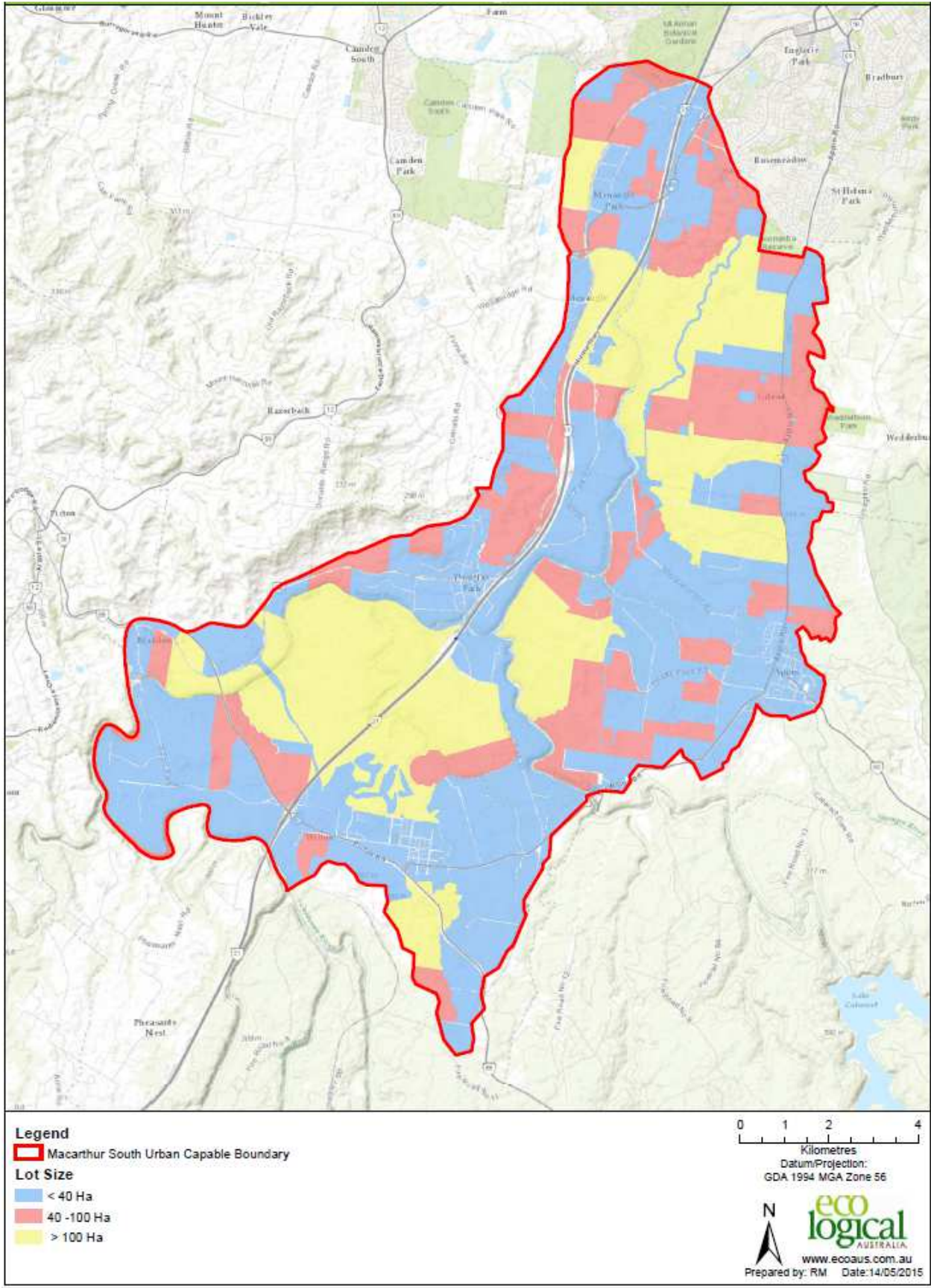
Map 11.11 GMIA – Aboriginal Archaeology and European Heritage



Map 11.12 Greater Macarthur Land Release Investigation Area Urban Areas



Map 11.13 Greater Macarthur Land Release Investigation Area - Land Fragmentation



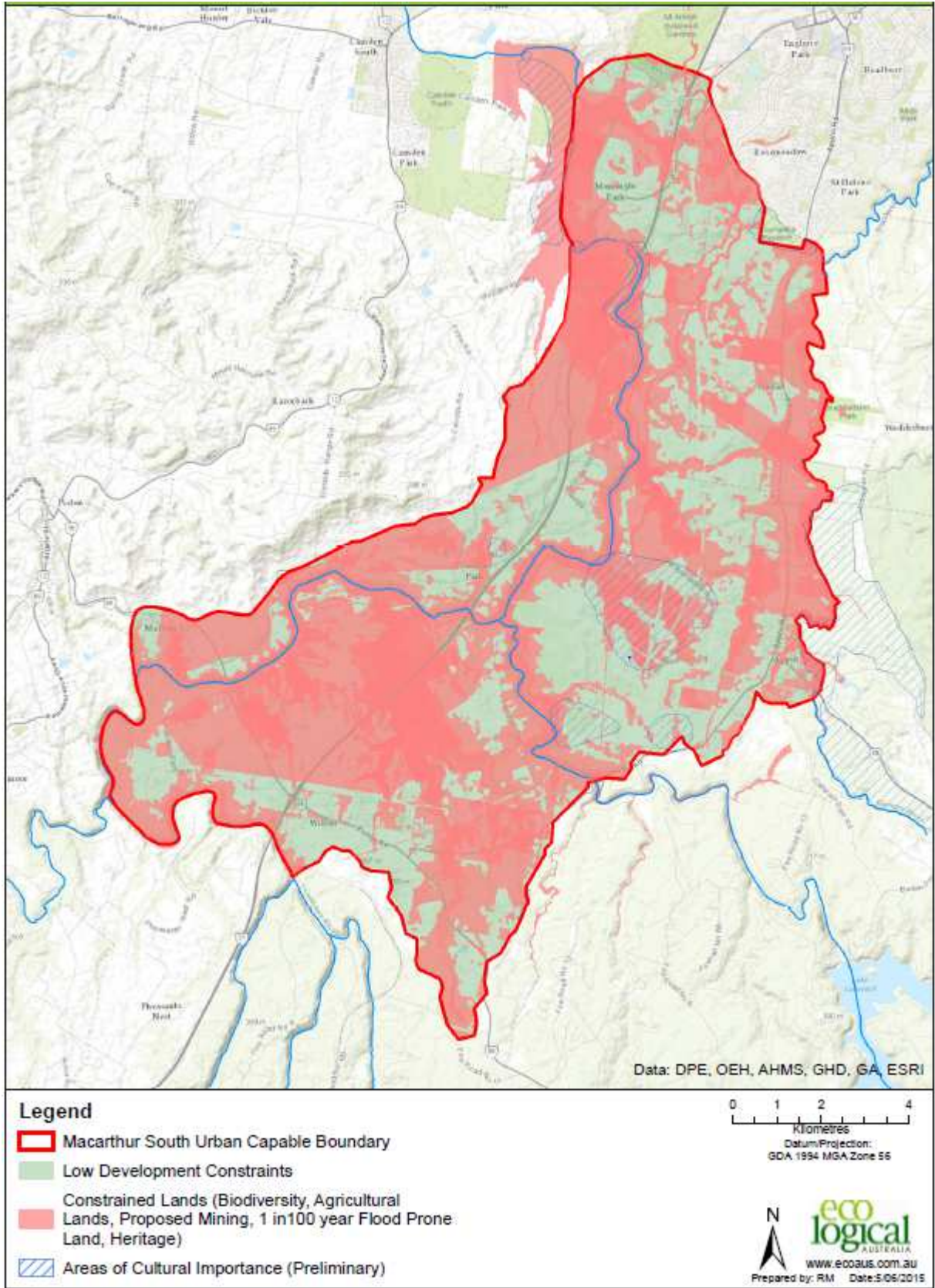
12 Identification of New Priority Growth Areas

Overlay of each of the maps along with consideration of values that have not been mapped shows considerable overlap. Consequently there is a need for land use trade-offs if part of the GMLRI is to be considered for future urban development. These trade-offs can be considered within a benefit cost analysis or similar framework and would need to consider the values and constraints presented here as well as other costs such as Government infrastructure costs.

Map 12.1 gives an indication of land not constrained by:

- Biodiversity values – good condition
- Agriculture – Class 2
- Mining – proposed underground
- Heritage – Aboriginal archaeology and historical heritage
- Flood prone lands

Map 12.1 GMLRI Unconstrained Areas Available for Urban Development



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