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Coal & Allied

Report for Lower Hunter Land Project - Phase 2

Water Sensitive Urban Design, Flooding and Stormwater Management: Minmi/Link Road

January 2009

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Executive Summary

Coal & Allied have identified landholdings that have development and conservation potential within the area covered by the Lower Hunter Regional Strategy. The lands examined in this report consist of four separate parcels, located at Minmi and Link Road. The parcels: Minmi West, Minmi East, Link Road North and Link Road South, represent a total land area of 543 hectares, all of which have been identified for development.

The creeks draining the Minmi and Link Road North sites discharge into the sensitive receiving environment of Hexham Swamp, a large wetland system of the Hunter River estuary. The Link Road South site gives rise to a number of tributaries, which converge into Brush Creek. Brush Creek eventually flows via other creeks into the northwest corner of Lake Macquarie. Minmi and Link Road experience a sub tropical climate with rainfall occurring in any given month throughout the year. Many land parcels have areas of steep gradients. In addition drainage catchments discharge at a number of locations from the site.

A number of opportunities for management of stormwater quality, quantity and flooding exist at the Minmi and Link Road sites. This management would benefit from the implementation of Water Sensitive Urban Design (WSUD) practices. WSUD encompasses all aspects of urban water cycle management including water supply, wastewater and stormwater management that promotes opportunities for linking water infrastructure, landscape design and the urban built form to minimize the impacts of development upon the water cycle and achieve sustainable outcomes.

A WSUD strategy for management of stormwater quality, quantity and flooding has been developed for the sites, that nominates on-lot treatment before discharge to the street stormwater system, vegetated swales and precinct scale co-located detention/ bio-retention basins at key locations. These systems would essentially comprise a dry basin (to provide detention function) combined with bio-retention (to provide water quality treatment function) situated in the invert of the basin. Gross pollutant traps and other structural measures are recommended at key locations. Rainwater tanks should be provided where possible. For flood management, habitable floor levels of new residences, and commercial developments should be above the flood planning level. A flood evacuation strategy would be provided for all areas inundated by the PMF.

At the site the majority of lots are located above the 100-year existing climate and 2100-climate change flood levels. For flood management, floor levels of dwellings should be above the flood planning level (500 mm above the 100-year ARI event flood levels). A minor affectation of internal roads and lots in isolated areas is expected. In a few isolated areas in the northern precincts the 100-year ARI event extends into the development footprint. In these locations, minor filling of the flood fringe would be required to ensure roadways and lots remain flood free. In addition, in a number of locations, minor tributaries, would be incorporated in the development footprint as part of the stormwater system. In these cases, the capacity of both the overland flow paths and underground stormwater system will be designed to provide a level of service that minimises the flood hazard.

The presence of numerous watercourses through the site has provided the opportunity to maximise the retention and designation of riparian corridors. The proposal seeks to encompass the intent of the Water Management Act where riparian corridors have been identified based on the stormwater conveyance and management requirements coupled with the desire to provide a diversity of habitat types for terrestrial and aquatic flora / fauna (further discussion on riparian corridors and corridor widths have been dealt with in the Ecological Assessment Report). The proposed riparian corridors widths allow for the conveyance of stormwater, management of water quality and flooding requirements, being cognisant of the topography and ecological value of the creeks. The Concept Plan identifies a range of buffer areas to creeks based on these corridor functions. In some instances the corridors are proposed to be rehabilitated and revegetated, improving bed and banking stability and reducing bank and channelling erosion. The enhancement of vegetation within these areas will therefore assist in protecting water quality by additional trapping sediment, nutrients and other contaminants as part of an overall comprehensive WSUD strategy. In general the flooding is contained within the assigned riparian corridor widths throughout the development.

Under a 100-year ARI future climate scenario, assuming a 30% increase in rainfall intensity, flood levels for majority of the site are expected to increase by less than 0.3 m. In the lower reaches near the discharge point to Hexham Swamp however, increases could be as much as 0.7m. While this does not cause a significant increase in flood extent, dwelling floor levels and flood planning levels would need to consider these impacts, and dwelling floor levels be located above these levels. A more detailed Floodplain Risk Management Study should be undertaken in future sub-division design stages of the project, supported by more detailed flood modelling and flood mapping

Numerical modelling was used to test the effectiveness of the WSUD strategy and included numerical modelling of flood peaks and flood levels for the creeks within the precinct using RAFTS and TUFLOW, volumes of detention that responded as best possible to the Concept Plan and which throttled flood peaks using RAFTS, and stormwater quality management using MUSIC.

The results of the numerical modelling has shown that the proposed WSUD strategy together with the flood plain management adequately satisfies the requirements of the NCC and LMCC DCP's and the NSW Floodplain Development Manual for management of stormwater quantity, quality and flooding at the precincts.

1. Introduction

1.1 Background

The Minister for Planning released the Lower Hunter Regional Strategy (LHRS) in 2006. These documents define the State Government's development strategy for the region, designating major centres, employment and conservation areas along with land releases for an additional 115,000 new dwellings. It covers the local government areas of Lake Macquarie, Newcastle, Maitland, Cessnock and Port Stephens.

Coal & Allied has identified landholdings that have development and conservation potential within the area covered by the LHRS. These lands total 4,187 hectares and comprise seven sites, four in the north and three in the south.

On 17 October 2006 the NSW Government reached agreement with Coal & Allied for the dedication of 3,322 ha (80 per cent) of Coal & Allied land for conservation corridors and development rights on 848 ha (20 per cent). The details of the negotiations are set out in a Memorandum of Understanding (MoU) between Coal & Allied, the Department of Planning, Department of Environment and Conservation and the Department of Lands.

1.2 Phasing of Study

The study is being undertaken in two phases, namely:

» Phase 1, which has been completed. The study presented an issues paper that relied on a desktop assessment, together with some ground truthing; and

» Phase 2, the subject of this report, comprises further investigations based on Concept Plans.

This Phase 2 supersedes the Phase 1 study.

1.3 Scope of Work

Phase 2 of the project required further development of the earlier findings as they apply to the Concept Plan, while addressing the Director General's Requirements. These requirements, in terms of surface water management, must address:

» Management of stormwater quantity and quality;

» Managing off-site impacts of runoff on receiving waters;

» Demonstrating a commitment to Water Sensitive Urban Design;

» Retention of valuable elements of existing drainage systems including wetlands and riparian corridors; and

» Consideration of climate change impacts on flooding.

This report provides documentation addressing the above while satisfying the broader range of Director General's Requirements.

1.4 The Site

The subject lands are located at Minmi and Link Road (north and south), shown in Appendix A. The sites are located to the northwest of the city of Newcastle and to the east of the Newcastle to Sydney Freeway. The summed parcels of land area cover 543 ha all of which have been identified for residential development.

The Minmi and Link Road North sites are located in the Newcastle City Council LGA, while the Link Road South site is located in the Lake Macquarie LGA.

1.5 Concept plan

This report responds to the Concept Plan shown in Appendix A.

1.6 Water Sensitive Urban Design (WSUD)

WSUD encompasses all aspects of urban water cycle management including water supply, wastewater and stormwater management. WSUD is a multi-disciplinary approach that promotes opportunities for linking water infrastructure, landscape design and the urban built form to minimise the impacts of development upon the water cycle and achieve more sustainable forms of urban development.

The principles of WSUD are incorporated in the Newcastle City Council DCP 2005 (NCC DCP 2005) and Lake Macquarie City Council DCP 1 (LMCC DCP 1). Councils' requirements in relation to stormwater management are to ensure systems are carefully planned, designed and located to prevent the disturbance, redirection, reshaping or modification of watercourses and associated vegetation and to protect the quality of receiving waters. If adequate WSUD measures are not adopted, the proposed development may have the following impacts:

- Increased stormwater runoff, potentially impacting sensitive downstream habitats in terms of flushing regimes (frequency, volume and rate), water quality and wetting cycles;
- Reduction in rainfall infiltration and decreased groundwater recharge; and
- Disturbance of groundwater flow due to site compaction, fill, landform reshaping and underground structures.

The suitability of WSUD solutions to any proposed development depends upon a number of factors, including climate and rainfall, site topography, geology and available land. Steeper slopes, make construction and siting of larger treatment measures such as offline community detention basins more difficult, while online systems upstream of road crossings are considered appropriate and practical. WSUD measures such as swales, bio-swales along with smaller detention basins and constructed wetlands are considered more suited to the Minmi and Link Road topography.

2. Existing Conditions and Derived Constraints

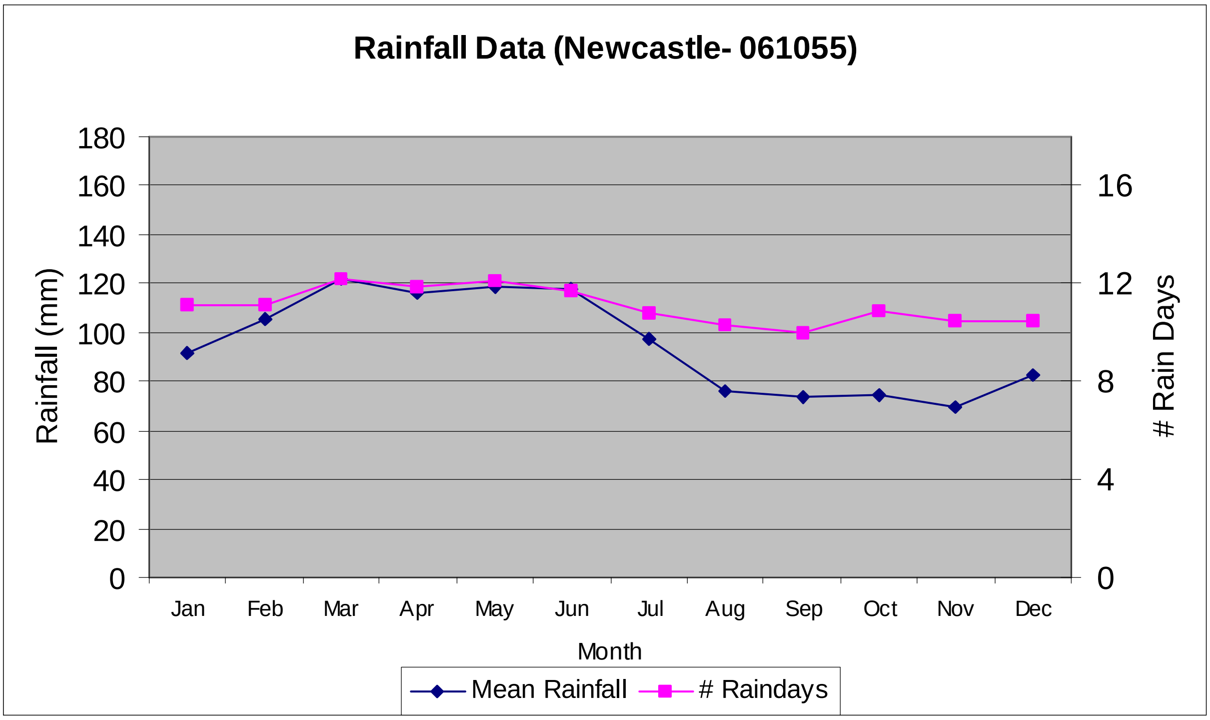
2.1 Climate and Rainfall

The Minmi and Link Road sites experience a sub-tropical climate with rainfall predominantly occurring in late summer and autumn. A typical operational daily rainfall station is located at Newcastle Nobby's Signal Station (BOM Stn 061055), which registered a mean annual rainfall of 1144.6 mm for the period 1862 to date.

Figure 1 shows the mean monthly rainfall and number of rain days recorded by the Newcastle station. The figure shows elevated monthly rainfalls in the months of February to July, with the least rainfall being recorded in August to November. The mean number of rain days varies between approximately 10 and 12 days of rain days per month.

The high likelihood of rainfall occurring in any month throughout the year would support utilisation of WSUD vegetated systems such as swales, bioretention, wetlands and detention basins to manage stormwater. Furthermore, the mild seasonal variability would indicate that rainwater collection via rainwater tanks might be viable.

Figure 1 Monthly Rainfall



2.2 Topography and Slopes

Topography is an important consideration when planning the location of stormwater management facilities, such as detention basins. On the Minmi sites, many land parcels have areas of steep gradients. In addition drainage catchments discharge at a number of locations from the site. In general slopes are highly variable and generally reflect a terrain that has been modified by past mining activity. The Link Road North site is located to the south of the existing Minmi village, at the extent of the Hexham Swamp catchment. This site slopes steeply towards the north. The Link Road South site, located south of Link Road, comprises more gentle slopes and drains towards the south and Lake Macquarie.

Areas of steeper slopes (greater than 5%) generally do not suit WSUD facilities such as bioretention swales. In these areas, flow attenuation via vegetated swales and bio-retention systems are less desirable due to excessive flow velocities, reduced detention times and potential scouring.

2.3 Soils and Erosion Risk

According to the Soil Landscapes of the Newcastle 1:100 000 Sheet (Matthie: 1995), the Northern Areas are underlain by four major and two minor soil landscape groupings. The major groupings are:

» *Killingworth Landscape* underlies most of the Minmi and Link Road North sites. The limitations of this soil group include high susceptibility to water erosion, shallow, low strength and highly acidic soils and seasonal water logging.

» *Cedar Hill Landscape* underlies much of the steeply sloped areas of the sites. The limitations of this soil group include susceptibility to erosion by mass movement and acidic soils.

» *Warners Bay Landscape* underlies much of the Link Road South site. The limitations of this soil group include high susceptibility to water erosion, localised steep slopes subject to mass movement hazard, highly acidic and low fertility soils and seasonal water logging.

» *Disturbed Terrain Landscape* is shown within a number of pockets across the land parcels. At these sites, the landscape has been highly modified due to past mining activity. In these areas, there is likely to be unconsolidated materials requiring rehabilitation prior to construction commencing.

The minor groupings are:

» *Beresfield Landscape* underlies some of the northern extent of the Minmi sites. The limitations of this soil group include high susceptibility to water erosion, highly acidic, low fertility soils and seasonal water logging.

» *Bobs Farm Landscape* is shown at the downstream end of some of the watercourses on the Minmi sites. These are low areas that contain remnant lake shore deposits and consequently have high potential for acid sulphate soil formation, high water tables, seasonal waterlogging and are prone to flooding.

The limitations of the soil groups and propensity to erosion would need to be considered when planning WSUD strategies.

2.4 Watercourses, Creeks and Receiving Waters

The watercourses draining the Minmi and Link Road North sites discharge into Hexham Swamp, a large wetland system of the Hunter River estuary.

The main channel of Minmi Creek flows through the Minmi West, to the west of the existing Minmi village area. Back Creek, a major tributary of Minmi Creek, rises on the Link Road North site, flows north through both the Minmi West and Minmi East sites, before entering Minmi Creek just prior to discharging into sensitive receiving environment of Hexham Swamp. There are a number of additional tributaries on the Minmi East site, discharging directly to Hexham Swamp.

The geomorphic features of many of these creeks have been highly modified by past mining activities and construction of the stormwater system for the existing Minmi village. Typically the upper reaches show defined bed and banks, steep bed slopes and good riparian vegetation along their length.

The Link Road South site gives rise to a number of tributaries, which converge, into Brush Creek. Brush Creek eventually flows through the urban areas of Edgeworth and Argenton and enters Cockle Creek at the Waratah Golf Club. Cockle Creek flows into the northwest corner of Lake Macquarie.

Issues relating to riparian corridors and corridor widths have been dealt with in the Ecological Assessment Report for Minmi and Link Road.

2.5 Adjoining Land Uses

The Minmi sites and Link Road North surround the existing Minmi Village, which currently supports both residential and rural residential development. The Sydney to Newcastle Freeway is located to the west and the Blue Gum Regional Park is located to the southeast of the site. The residential area of Fletcher and the Summer Hill Waste Management Facility are located further to the east.

The Link Road South site is located adjacent to the existing residential area of Cameron Park, with an industrial estate on Cameron Park Drive to the west.

2.6 Statutory Requirements

2.6.1 Legislation

The proposed development will be completed under Part 3A of the *Environmental Planning and Assessment Act 1979 (EPAA).*

Natural resource legislation that applies for the assessment of the development includes:

» *Environmental Protection and Biodiversity Conservation Act 1999* – administered by the Commonwealth Department of Environment and Heritage. This requires assessment and approval of any activities impacting upon matters or areas of national significance;

» *Protection of the Environment Operations Act 1997* – administered by the NSW Department of Environment and Climate Change. Under this Act it is an offence to undertake any activity which results in pollution of land, air or water; and

» *Water Act 1912* – administered by the NSW Department of Water & Energy. Requires granting of water licences to control, use or alter flow in any river or aquifer.

2.6.2 Statutory Plans

Further to the legislative requirements any proposed rezoning of the investigation must consider the requirements of the following planning documents:

- Lower Hunter Regional Strategy – the strategy identifies areas for development of residential land to the west of Newcastle, including the sites covered by the Minmi and Link Road;
- Draft Lower Hunter Regional Conservation Plan – the plan proposes a green corridor that links the Watagans and Yengo national parks with the coastal plains of the Tomago Sand beds, Stockton Bight and Port Stephens;
- Integrated Catchment Management Plan for the Central Coast 2002 and Draft Hunter Central Rivers Catchment Management Authority (HCRCMA) Catchment Action Plan 2006 – both plans are administered by the HCRCMA and priorities investment in natural resource management for this area;
- NCC LEP and Development Control Plan 2005 - guides development across the Newcastle LGA, notably in the areas of flood and water management and gives special consideration to the area of Minmi.
- Lake Macquarie City Council LEP and Development Control Plans 1 and 2 – outline requirements for development within or near water bodies, floodplains, steep lands, acid sulfate soils, mine subsidence districts and heritage conservation areas; and
- LMCC Coastline Management Plan – adopted by Council in 1999, identifies works required to along the Lake Macquarie Coastline in order to maintain and enhance its natural, visual and recreational amenity.

The most critical regional strategies that inform the development of Coal & Allied lands are the Lower Hunter Regional Strategy and the Draft Lower Hunter Regional Conservation Plan. This is addressed in detail, in the Environmental Assessment prepared by Urbis.

2.6.3 Relevant Policies

State Environmental Planning Policies that are relevant include the:

- SEPP Major Projects, which applies to any project considered under Part 3A; and
- Hexham Swamp contains areas of designated SEPP 14 (Coastal Wetlands). However, a significant vegetated buffer of 1 to 2 km separates the discharge point of Minmi Creek from the SEPP 14 boundary. Therefore, in-stream treatment and modification of stormwater flows is likely to occur prior to it reaching the SEPP 14 area. Nonetheless, consideration must be given to the protection of this sensitive and important wetland area.

3. Design Criteria and Supporting Simulations

3.1 Design Criteria and Environmental Objectives

3.1.1 Stormwater Quality

The ANZECC Guidelines (ANZECC, 2000) nominate default trigger values for south-east Australian aquatic ecosystems, below which environmental impacts are not expected to occur. The values most applicable to stormwater pollution are Total Nitrogen (TN) and Total Phosphorous (TP). For these two constituents, trigger values of 0.5 mg/L (TN) and 0.05 (TP) are nominated in the guidelines. Ideally baseline field data would be used to assess potential impact of the development, however this data is not available.

LMCC guidelines (DCP 1) nominate target pollutant removal efficiencies for a range of pollutants for residential developments greater than 2 hectares as indicated in Table 1 below.

Table 1 LMCC Stormwater Treatment Measure Effectiveness

Pollutant	Target Pollutant Removal Efficiency
Gross Pollutants (kg/yr)	High - Very High (80 – 100%)
Total Suspended Solids (kg/yr)	Moderate – High (30 – 80%)
Total Phosphorus (kg/yr)	Moderate (30 – 50%)
Total Nitrogen (kg/yr)	Moderate (30 – 50%)

NCC guidelines nominate target maximum event mean concentrations for a range of pollutants for developments as indicated in Table 2 below.

Table 2 NCC Stormwater Treatment Measure Effectiveness

Pollutant	Maximum Event Mean Concentration
Sediment	100 mg/l
Hydrocarbons	500 μg/l
Total Nitrogen	1000 μg/l
Ammonia	15 μg/l
Phosphorus	100 μg/l

For this project, it is nominated that the LMCC guidelines (DCP 1) for determining the effectiveness of stormwater treatment strategies be adopted. These guidelines are considered better suited for the range and concentration of pollutants associated with a residential development.

3.1.2 Stormwater Quantity and Flood Risk

If not managed, increased impervious areas on account of development could increase flood peaks and discharge from the site. It is therefore necessary to manage increased discharges according to the requirements of the relevant DCP. In the Link Road South site, the relevant DCP is LMCC DCP 1, which stipulates:

- Post development 20-year Average Recreance Internal (ARI) flood peaks should not exceed 5-year existing condition flood peaks; and
- Post development 100-year ARI flood peaks should not exceed 100-year existing condition flood peaks.

In addition, development and land-use in flood prone areas should be in accordance with LMCC Floodplain Management Policy and the NSW Floodplain Development Manual.

For the NCC LGA (Minmi and Link Road North), development should not increase flood risk over and above existing conditions. It is therefore necessary to control discharges from the site according to the requirements of NCC's DCP 2005 and Stormwater and Water Efficiency for Development Technical Manual. These documents stipulate that in the absence of the Newcastle City Council revised Subdivision Code to assist in the development of estates (currently being compiled):

- Stormwater management measures are to be installed within the public domain area (including easement under Council control) and are to be sized on the assumption that 60% of new road reserve areas plus 20% of allotment areas are impervious;
- Development is to be designed so that peak runoff from the site for all events including the 1 Year Average Recurrence Interval (ARI) through to the 100 year ARI, is not greater than for the "natural" drainage conditions;
- On-lot storage provision, in accordance with Table 3; and
- The above, combined with storage requirements for on-lot detention, should satisfy the objectives. All public stormwater management assets are to be installed outside the riparian zone of creek lines.

Development and land-use in flood prone areas should be in accordance with NCC Flood Management Technical Manual and the NSW Floodplain Development Manual.

		Impervious area									
		100 m2	250 m2	300 m2	350 m2	500 m2	600m2	750 m2	1000 m2	1,500 m2	2,000 m2
Site area	100 m2	2.5 m3									
	250 m2	1.2 m3	6.3 m3								
	500 m2	1.2 m3	3.1 m3	4.4 m3	6.0 m3	12.5 m3					
	600 m2	1.2 m3	3.1 m3	3.6 m3	5.0 m3	10.3 m3	15.0 m3				
	750 m2	1.2 m3	3.1 m3	3.6 m3	4.2 m3	8.2 m3	11.9 m3	18.8 m3			
	1000 m2	1.2 m3	3.1 m3	3.6 m3	4.2 m3	6.0 m3	8.8 m3	13.9 m3	25.0 m3		
	1,500 m2	1.2 m3	3.1 m3	3.6 m3	4.2 m3	6.0 m3	7.2 m3	9.0 m3	16.3 m3	37.5 m3	
	2,000 m2	1.2 m3	3.1 m3	3.6 m3	4.2 m3	6.0 m3	7.2 m3	9.0 m3	12.0 m3	27.8 m3	50.0 m3

Table 3 NCC's DCP 2005 On-site Storage Requirements

3.2 Supporting Simulations

Numerical modelling was used to assess the flood and stormwater management, which included:

- Defining existing conditions flood peaks and flood levels for the creeks within the precinct, for a range of design storm events (using RAFTS and TUFLOW);
- Determining appropriate volumes of detention throughout the precinct, that responded as best possible to the Concept Plan and which throttled post development flood peaks to existing condition flood peak levels to the requirements of the design criteria (using RAFTS);
- Simulating stormwater runoff quantity and quality for the developed scenario (using MUSIC); and
- Determining appropriate strategies for stormwater quality management throughout the development, which responded as best possible to the Concept Plan and which achieved the pollution load export requirements set by the design criteria (using MUSIC).

All modelling should be considered as preliminary and would need to be updated at later stages with more detailed studies, when better information on landform, development footprints, creek works and road configurations are known.

3.2.1 Existing Flood Risk

Flood Peaks and Detention

Flood peaks for calculating flood extent associated with all the creeks at the site were simulated using the RAFTS hydrological model. Compilation of the model included:

- Catchment delineation;
- Hydrological parameter determination; and
- Intensity-Duration-Frequency (IFD) determination for generating storm rainfall events.

Detention requirements for the site were determined using three “pilot” catchments, two in the Minmi and Link Road North development area, and one in the Link Road South development area. Since hydrological conditions and proposed development are similar for this site, the results were transposed for the entire development. In addition, as will be shown later, the proposed strategy relies on a combination of on-lot and precinct scale detentions. To this end this “pilot” approach was deemed acceptable.

RAFTS simulations were undertaken for a number of design storms (2-, 5-, 10-, 20- and 100-year ARI events and the PMF) and for durations ranging from 25 minutes to 9 hours (PMF 15 minutes to 6 hours). For each event the critical duration was determined. Three scenarios were simulated, namely:

- Existing (undeveloped) conditions;
- Developed conditions with assumptions as described below, in regard to impervious percentages and losses; and
- Developed conditions with required volume of detention, to mitigate increased flood peaks on account of the development.

Percentage impervious areas for the hydrology model were stipulated as follows:

- Residential = 70%; and

- Road = 100%.

Key infiltration parameters assumed in the RAFTS modelling are provided in Table 4 below.

Table 4 Infiltration Parameters

	Pervious	Impervious
Initial loss (mm)	15	2.5
Continuing loss (mm/hr)	2.5	0

Existing 100-year and PMF Flood Levels

Flooding was determined with the 2 dimensional TUFLOW hydraulic model. TUFLOW is a hydraulic model for simulating depth-averaged, two and one-dimensional free surface flows. Data is input through the use of text files for controlling simulations and simulation parameters. MapInfo files are used to represent spatially distributed data such as topography, hydraulic structures and boundary conditions.

The TUFLOW model compilation was undertaken as follows:

- The available 2 m contour data for the site was imported into the digital terrain model program 12D. The creek areas were extracted and triangulated into a Digital Terrain Model (DTM) to represent the ground surface;
- A TUFLOW grid was generated with a cell size of 2 m. Each point in the grid was given an elevation based on its location in the 12D DTM. The grid size was chosen because this is a compromise between the accuracy of the DTM data, simulation run time, model stability, and the accuracy of the results;
- No road crossings were simulated at this early planning stage, and thus the modelling represents conservative scenario (worst case) of blocked culverts;
- Supplied cadastral information was imported into GIS program and the aerial photography geo-referenced;
- The sub-catchments used in the RAFTS hydrologic modelling were applied as inflows over the 2-D model, with inflows distributed and divided over the model grid points;
- Based on aerial photography and site inspections, hydraulic roughness coefficients for the floodplain were recorded for the model. These coefficients were digitised into MapInfo as polygons to represent the various surfaces; and
- Downstream control was in the form of flood levels were determined by adopting flood levels within Hexham Swamp as calculated by DHI.

In the absence of corresponding rainfall (hyetograph) and runoff data, calibration of the TUFLOW model was not possible. Furthermore no historic flood markers were available for calibrating of overland flood depths. Calibration of the model was thus limited to checking the “reasonableness” of the overland flow routes and depths, and qualitatively comparing the findings to known flooding occurrences.

Existing conditions flood maps are provided in Appendix B. In general, the results show:

- In the upper reaches of the catchment, floodplains are confined in many cases within the deeply incised creek channels;
- A significant flood plain exists in the lower reaches, where floodplains open up to Hexham Swamp;

- The PMF flood extents are only marginally larger in flood extent compared with the 100-year ARI flood extents due to the steeper terrain; and
- Flood extents on certain tributaries are dominated by culverts under roadways, which result in backwater upstream of the culverts.

3.2.2 Stormwater Quality Management

Stormwater quality was assessed using the MUSIC model. The model was configured and simulated for the existing and post-development conditions in response to the Concept Plan. Three “pilot” catchments, two in the Minmi and Link Road North development area, and one in the Link Road South development area were configured. Since hydrological conditions and proposed development are similar for this site, the results were transposed for the entire development. To this end this “pilot” approach was deemed acceptable. Potential pollution treatment devices were assessed in the model, which included swales, bio-retention areas, wetlands, gross pollutant traps, sediment basins, ponds and filter strips.

Historical rainfall for this assessment was obtained from the Bureau of Meteorology (BOM) pluviograph data for Williamtown RAAF base for the period December 1952 to January 2005. Williamtown rainfall was chosen for this assessment as it had the longest and most complete period on record of 6 minute rainfall for the Lower Hunter.

For this simulation period there were several high rainfall events as well as periods of low rainfall with an average rainfall for the period of 1023mm/year. The evaporation data used in the model was obtained from the Bureau of Meteorology long-term averages for each month with the average annual evaporation for Williamtown being 1732mm/year.

In pursuing WSUD, Newcastle City Council and Lake Macquarie City Council are paying specific attention to the regular low, or base, flows from catchment areas. These flows are of particular importance as they convey the majority of pollutants from catchments to downstream locations, in this case Minmi Creek and subsequently Hexham Swamp for the Minmi East and West and Link Road North sites, and Brush Creek and subsequently Cockle Creek for the Link Road South Site.

3.3 Climate Change

The Lake Macquarie City Council report Planning Levels and Other Adaptation Reponses to Sea Level Rise and Climate Change, accepted:

“ that sea level rise is a well-documented phenomenon over the last fifty years. The best available scientific evidence at hand suggests an increase in sea levels over the current century. Council is aware of the growing risk from sea level rise and climate change.

Accepting a sea level rise prediction of 0.91m for the period up to 2100 will address Council’s immediate ‘duty of care’ responsibilities. After consultation, and using the resulting figure as a basis, development of future adaptation and planning initiatives will allow Council to act on the side of reasonable caution in addressing climate change related impacts.

Increased ocean levels and increased frequency and severity of flood-producing rain events require an urgent response, with a recommended immediate increase in the habitable floor heights in areas predicted to be affected by sea level rise. However, flood behaviour is site specific and future flood studies and floodplain risk management studies will consider the implications of climate change as part of strategic management of flood risk, as required by the NSW Floodplain Development Manual 2005.”

"The best available advice from the Department of Environment and Climate Change (DECC Practical Consideration of Climate Change, October 2007) indicates that sea level rise on the NSW coast is expected to be in the range of 0.18 to 0.91m by between the years 2090 and 2100.

It is proposed that Council adopt a provisional sea level rise figure for the year 2100 of 0.91m in order to err on the side of reasonable caution and provide an approach based on the precautionary principle. The adoption of this figure equates to 10 mm per year rise up to the year 2100."

"The effect of adopting the above figure is that development consents this year for buildings potentially affected by sea level rise will require 10 mm to be added to the required floor height for each year of the buildings' designated economic life.

The DECC Practical Consideration of Climate Change, October 2007 guidelines recommend that the following sensitivity analyses be undertaken for sea level where relevant to the study area:

» 0.18m (Low Level Ocean Impacts)

» 0.55m (Mid Range Ocean Impacts)

» 0.91m (High Level Ocean Impacts)

In addition until more work is completed in relation to the climate change impacts on rainfall intensities the following sensitivity analyses are recommended:

Rainfall Intensities increases of:

» 10% in peak rainfall and storm volume

» 20% in peak rainfall and storm volume

» 30% in peak rainfall and storm volume

Given the site location the ocean impact scenario was not considered. However a 30% increase in storm rainfall intensity and storm volume was simulated. This was considered a representative scenario of climate change for a 2100-planning horizon. On this basis, the RAFTS and TUFLOW models were resimulated.

The impacts of the above climate change scenarios are shown in Appendix C. In general the figures show that:

» Flood extents in the 100-year ARI climate change scenario increase by a small amount adjacent to the precincts in the steeper upper reaches of the creeks. In the lower reaches, the impact is slightly more given the larger floodplain;

» In a 100-year ARI event climate change scenario, flood levels adjacent to the site are expected to increase by less than 0.3 m in the upper reaches. While this does not cause a significant increase in flood extent, dwelling floor levels would need to consider these impacts; and

» In the lower reaches flood levels, where creeks discharge to Hexham Swamp, flood level impacts increase to 0.7m. Again dwelling floor levels will need to consider these impacts

4. Concept Plan and Potential Stormwater Impacts

Increased impermeable surfaces (roofs, driveways, roads, pavements etc.) on account of development alter the hydrological cycle. If not managed effectively, this 'hardening' of the surfaces has the potential to:

- Increase stormwater peak flows, leading to increased flood risk and erosion (on-site and off-site);
- Increase stormwater runoff volumes, which could impact downstream sensitive habitats in terms of flushing regimes (frequency, volume and rate), water quality, and wetting cycles;
- Increase stormwater pollution discharged to receiving environments as a result of pollutant entrainment in the increased runoff. The type of development and associated activities may introduce differing pollutant profiles, for example vehicular traffic could increase hydrocarbon introduction. In general, typical pollutants include litter, sediment, suspended solids, nutrients, hydrocarbons and toxicants;
- Reduce rainfall infiltration to the soil leading to impacts to the water balance, (including groundwater recharge and salinity impacts); and
- Impact groundwater flow due to site compaction, fill, landform reshaping and underground structures.

The above are the long-term potential impacts however during construction there are additional impacts to pollution, erosion and sedimentation. Increased sedimentation on account of landform disturbances and accidental spills within unbunded areas of the site could discharge to the receiving environment. Clearing and earthmoving activities have the potential to impact on surface water quality in the vicinity of the site, especially during high rainfall events. The activities and aspects of the works that have potential to lead to erosion, sediment transport, siltation and contamination of natural waters include:

- Earthworks undertaken immediately prior to rainfall periods;
- Work areas that have not been stabilised and clearing of land in advance of construction works;
- Stripping of topsoil, particularly in advance of construction works;
- Bulk earthworks and construction of pavements;
- Washing of construction machinery;
- Works within drainage paths, including depressions;
- Stockpiling of excavated materials;
- Storage and transfer of oils, fuels, fertilisers and chemicals; and
- Maintenance of plant and equipment.

To reduce the potential pollutant export during construction, a detailed Water Management Plan and associated Sediment and Erosion control plan would need to be developed during the detail design phase of the project.

5. WSUD Management Strategy

5.1 General

5.1.1 Principles

Water usage and water conservation along with maintaining the health of the surrounding environment are important considerations of any proposed development. The Minmi and Link Road sites are located in an area that is sparsely populated with significant aesthetic amenity and as such these considerations have been given a great deal of emphasis.

Local Councils are acutely aware of the need to maintain the health of the natural environment and have developed a comprehensive range of criteria for all new developments. This criterion includes, but is not limited to, the inclusion of stringent stormwater quantity and quality limits that require the adoption of a range of WSUD treatment measures to form a treatment train.

In general, the principles for stormwater management at the Minmi and Link Road sites should aim to retain as much stormwater as possible on site, transport as little stormwater as possible to receiving waters, 'lose' as much stormwater as possible along the treatment train and slow the transmission of stormwater to receiving waters.

5.1.2 Objectives

In applying the above principles, the key planning and design objectives are generally:

- Protect and enhance natural water systems in urban developments;
- Integrate stormwater treatment into the landscape by incorporating multiple-use corridors that maximise the visual and recreational amenity of the development;
- Protect water quality draining from the development;
- Reduce runoff and peak flows from developments by employing local detention measures, minimising impervious areas and maximising re-use; and
- Add value while minimising drainage infrastructure development costs.

The development of a stormwater management plan to achieve the above will also consider flood management, flow management, water quality management and flow attenuation.

5.1.3 Site Opportunities

General opportunities for WSUD at the Minmi and Link Road sites include:

- Maximise source control measures in preference to end of line treatment measures;
- Orientate roads to traverse contours, providing slopes with grades of 4% or less to promote the provision of above ground conveyance mechanisms such as vegetated swales into the streetscape;
- Maintain and re-establish vegetation along waterways and provide public open space along drainage lines to develop multi-use corridors linking public and private areas;
- Preserve and restore existing valuable elements of the stormwater drainage system such as wetlands, natural channels and riparian vegetation;

- Manage the quality and quantity of stormwater at or near the source, which will involve a significant component of public education and community involvement. Treatment practices such as community wetlands and detention basins to manage water quality could be provided downstream or close to the point of discharge from development areas, before discharge to key riparian and waterway areas; and
- Provide 'structural' stormwater quantity and quality management practices that provide flood management, flow attenuation and volume reduction, along with water quality management. Typical structures include detention basins, bioretention basins, lakes, ponds, wetlands, rehabilitated waterways and water re-use schemes. Furthermore provide primary stormwater treatment measures that target litter, gross pollutants and coarse sediments and secondary treatment measures that target fine sediment, nutrients and bacteria.

5.2 The Minmi and Link Road WSUD Strategy

5.2.1 Strategy Drivers

The proposed WSUD strategy for The Minmi and Link Road sites is provided in Appendix D. A number of specific "drivers" were identified, which have guided the Minmi and Link Road WSUD strategy development:

- Requirements of the relevant Council DCP's;
- The steep site topography and incised riparian corridors in the upper reaches:
  - Does not favour large detention or bioretention basins before discharge to creek lines;
  - Favours on-lot treatment before discharge to the local stormwater system in the roads and discharge to the riparian corridors;
  - Does not favour in-street swales unless grades are less than 4%;
  - Provides opportunity to locate stormwater treatment facilities (for example detention or bioretention basins) upstream of local road crossings using the road embankment at a discharge control;
  - Requires careful consideration of increased runoff quantity and peak flow on the erosion potential in creeks;
  - Favours smaller cascading basins (for example detention or bioretention basins) in creeks to detain and dissipate energy of flow and prevent erosion.
- The undulating site topography:
  - Requires management of stormwater at a number of discharge points corresponding to existing drainage lines;
- The flatter site topography in the lower reaches:
  - Favours larger co-located bioretention and detention basins offline before discharge to creeks;
  - Favours opportunistic provision of swales in the street;
  - Favours co-located open space/public amenity and stormwater treatment measures;
- The residential nature of the proposed development:
  - Favours provision of on-lot detention using designated storage in rainwater tanks or separate stormwater detention tanks;

- – Favours maximised on-lot treatment of runoff, however does not favour total reliance on this strategy, as limited control on maintenance of the systems can be exercised;
- – Favours precinct scale for road runoff, using swales and basins.

5.3 Stormwater Quality Management

- » Runoff will be treated on individual lots, before discharge to the street drainage system. This can be achieved using:
  - – Roof water tanks;
  - – Infiltration and retention devices;
  - – Permeable paving;
  - – Using crushed gravel or other treatments instead of paving
  - – Swales & other landscape measures;
  - – Sand/gravel filters for runoff from car parks and driveways;
  - – Reducing the area of paving (for example, driveway strips); and
  - – Diverting runoff from driveways onto garden beds before leaving the property.
- » Runoff from roads will be treated using:
  - – Vegetated infiltration swales (bio-retention in the invert) along the identified main overland flow routes adjacent to the road. The required width of the vegetated swales are approximately 4 to 6 m and road cross-fall would need to convey runoff to the swales; and
  - – Smaller bioretention basins upstream of local road crossings in steeper areas. In other areas, the basins would be located offline, discharging to riparian corridors. The basins would provided both detention and water quality treatment function;
- » Gross pollutant traps and other structural measures would be provided throughout critical locations as required, before discharge to the basins; and
- » Provision of rainwater tanks in all areas should be maximised in accordance with Council's requirements.

Three "pilot" catchments, two in the Minmi and Link Road North development area, and one in the Link Road South development area were configured in the MUSIC model, to test the effectiveness of the proposed strategy. Since hydrological conditions and proposed development are similar for this site, the results were transposed for the entire development. To this end this "pilot" approach was deemed acceptable.

The results listed in Table 5 to Table 7, show that the proposed treatment satisfies Councils nominated target pollutant removal requirements, in particular LMCC DCP1. Opportunities for configuring on-lot treatment are provided in Appendix D. In general the required treatment area required is approximately 2% of the developed footprint, however additional land needs to be provide to allow for embankments and local landscaping associated with the facilities. Thus approximately 4% of the developed area may need to be provided. The required area will be dependant on the local topography. It is proposed to co-locate the stormwater quality treatment areas (bioretention areas) within detention basins.

Table 5 Stormwater Treatment Measure Effectiveness South of Link Road

	Post Development (kg/yr)	Post-development (with WSUD) (kg/yr)	% Reduction using WSUD	Target Pollutant Removal Efficiency
Total Suspended Solids	111000.00	5040.00	95	Moderate – High (30 – 80%)
Total Phosphorus	227.00	38.50	83	Moderate (30 – 50%)
Total Nitrogen	1640.00	767.00	53	Moderate (30 – 50%)
Gross Pollutants	16700.00	143.00	99	High - Very High (80 – 100%)

Table 6 Stormwater Treatment Measure Effectiveness North of Link Road (Catchment 1)

	Post Development (kg/yr)	Post-development (with WSUD) (kg/yr)	% Reduction using WSUD	Target Pollutant Removal Efficiency
Total Suspended Solids	6640.00	256.00	96	Moderate – High (30 – 80%)
Total Phosphorus	13.60	2.22	84	Moderate (30 – 50%)
Total Nitrogen	93.20	46.00	51	Moderate (30 – 50%)
Gross Pollutants	961.00	0.00	100	High - Very High (80 – 100%)

Table 7 Stormwater Treatment Measure Effectiveness North of Link Road (Catchment 2)

	Post Development (kg/yr)	Post-development (with WSUD) (kg/yr)	% Reduction using WSUD	Target Pollutant Removal Efficiency
Total Suspended Solids	69000.00	3250.00	95	Moderate – High (30 – 80%)
Total Phosphorus	141.00	23.60	83	Moderate (30 – 50%)
Total Nitrogen	980.00	468.00	52	Moderate (30 – 50%)
Gross Pollutants	10300.00	133.00	99	High - Very High (80 – 100%)

The results listed in Table 8, show that the proposed treatment results in TN and TP pollutant concentrations below the ANZECC trigger values.

Table 8 ANZECC Guideline Trigger Values for Aquatic Ecosystems

Catchment	TP mg/L	TN mg/L	Guideline Trigger Values	
South of Link Road	0.019	0.42	TP = 0.05 mg/L	TN = 0.5 mg/L
North of Link Road (Catchment 1)	0.018	0.38		
North of Link Road (Catchment 2)	0.016	0.37		

The presence of numerous watercourses through the site has provided the opportunity to maximise the retention and designation of riparian corridors. The proposal seeks to encompass the intent of the Water Management Act where riparian corridors have been identified based on the stormwater conveyance and management requirements coupled with the desire to provide a diversity of habitat types for terrestrial and aquatic flora / fauna (further discussion on riparian corridors and corridor widths have been dealt with in the Ecological Assessment Report). The proposed riparian corridors widths allow for the conveyance of stormwater, management of water quality and flooding requirements, being cognisant of the topography and ecological value of the creeks. The Concept Plan identifies a range of buffer areas to creeks based on these corridor functions. In some instances the corridors are proposed to be rehabilitated and revegetated, improving bed and banking stability and reducing bank and channelling erosion. The enhancement of vegetation within these areas will therefore assist in protecting water quality by additional trapping sediment, nutrients and other contaminants as part of an overall comprehensive WSUD strategy.

5.3.1 Managing Construction Phase Stormwater Quality Impacts

Construction phase water quality impacts will be managed through the implementation of a Soil and Water Management Plan detailing stormwater management strategies in accordance with ‘Soils and Construction, Managing Urban Stormwater’ (Landcom 2004). Specific strategies may include:

» Material management practices;

» Stockpile practices;

» Topsoil practices; and

» Erosion control practices (earth sediment basins, straw bales, sediment fences, turbidity barriers, stabilised site accesses, diversions and catch drains).

Monitoring, including visual inspections and water quality sampling, will be required as part of any development consent to ensure that management strategies are working effectively.

5.4 Flooding and Stormwater Quantity Management

5.4.1 Detention

» Detention will be provided on individual lots, before discharge to the street drainage system. This can be achieved using tanks, landscape measures and/or detention zones in rainwater tanks;

- Precinct scale detention basins are proposed at locations where local roads cross over creeks and tributaries. The culvert under the road could be used as a throttle, allowing attenuation of increased flood peaks upstream of the road crossing. The required detention areas are estimated based on the contributing developed sub-catchments. In some locations these detention facilities could be co-located with bioretention to provide the dual purpose of stormwater quantity and quality management; and
- Rainwater tanks should be provided for each dwelling. The size of the tanks will be decided as part of the lot development process. Even though the purpose of rainwater tanks is for roof water harvesting and reuse, they also detain the stormwater flows to a certain extent. However this function was not included in assessing the required detention storage volume.

To test the effectiveness of the strategy, detention storage basins were configured in the RAFTS model for three pilot catchments. In general it was found that the permissible site discharges and minimum storage requirements in Table 9 and Table 10 close satisfy Council requirements in terms of detention.

The required detention storage for the off-site portion equates to approximately 3% of the developed footprint, however additional land needs to be provide to allow for embankments and local landscaping associated with these basins. Thus approximately 5% of the developed area may need to be provided. This result generally compares favourably with detention requirements for other land developments undertaken by GHD in the region.

It is proposed to co-locate the bioretention stormwater quality treatment areas with these detention storage facilities. It is anticipated that as these detention basins will be community-based facilities to achieve the detention requirements and that they will be allocated to Council ownership at the completion of the construction. As such these structures will then be operated and maintained by Council.

Table 9 Detention Strategies Link Road South (after LMCC design criteria)

Catchment	Maximum permissible site discharge (l/s/ha)	Minimum required detention storage (m^3/ha)
On-Lot	80	280
Precinct Basin	90	140

Table 10 Detention Strategy for Minmi and Link Road North (after NCC design criteria)

Catchment	Maximum permissible site discharge (l/s/ha)	Minimum required detention storage (m^3/ha)
On-Lot	NCC DCP (see Table 4)	NCC DCP (see Table 4)
Precinct Basin	170	280

Table 11 shows the effectiveness of the detention strategy at a pilot catchment. The table shows that the developed 20-year ARI flood peak flow is throttled to the existing 5-year ARI peak flow.

Table 11 Effectiveness of Detention Strategy – Link Road South (LMCC area)

Pilot Catchment Area	Flood Peak (m^3/s) for critical duration			
	Existing – 5 year ARI	Developed with mitigation – 20 year ARI	Existing – 100 year ARI	Developed with mitigation – 100 year
83 ha	5.69	5.93	10.05	7.80

Table 12 shows the effectiveness of the detention strategy at two pilot catchments. The table shows that the developed 10 year ARI and 100 year ARI flood peak flows are throttled to the existing peak flows.

Table 12 Effectiveness of Detention Strategy – Link Road North (NCC area)

Pilot catchment Area	Flood Peak (m^3/s) for critical duration			
	Existing – 10 year ARI	Developed with mitigation – 10 year ARI	Existing – 100 year ARI	Developed with mitigation – 100 year
4 ha	0.42	0.38	0.72	0.58
49.3 ha	4.53	3.92	7.81	6.24

5.4.2 Flooding and Flood Risk

Development and land-use in flood prone areas should be in accordance with the NCC Flood Management Technical Manual, Lake Macquarie Floodplain Management Policy and the NSW Floodplain Development Manual. In assessing the flood risk, consideration needs to be given to the full range of risks to people and property, for a full range of flood events up to and including the PMF. Interim development guidelines specify, amongst others:

» Habitable floor levels of new residences together with normally occupied floors of special use developments should either be at or above the Flood Planning Level and be flood proofed to this level (making additional provision for potential subsidence);

» In flood storage and flood way areas, development must not lead to a significant increase in flood levels, flood damages, flood behaviour or flood hazard at the site or elsewhere. Provision of adequate and acceptable compensating works to offset must be provided; and

» In high flood hazard areas, effective evacuation procedures must be provided.

All dwellings would be located above the 100-year ARI flood level associated with the creeks, local overland flow paths and stormwater management facilities across the site. It is proposed that Flood Planning Levels be adopted that locate floor levels of dwellings with a freeboard of 500 mm above 100-year ARI flood levels.

Referring to Appendix D, where the 100-year ARI flood is overlayed with the WSUD strategy and the Concept Plan, the following is noted:

- Areas of inundation are primarily associated with riparian corridors. In a few isolated areas in the northern precincts the 100-year ARI event extends into the development footprint. In these locations, minor filling of the flood fringe would be required to ensure roadways and selected areas on lots remain flood free. However the final lot usage could incorporate the edge of the floodplain in the lot planning as open space;
- In a number of locations, minor tributaries, would be incorporated in the development footprint as part of the stormwater system. In these cases, the capacity of both the overland flow paths and underground stormwater system will be designed to provide a level of service that minimises the flood hazard. Flood hazard is a product of both overland flow depth and velocity. In order to limit the hazard both of these need to be controlled. For the underground system, this would be achieved by providing a sufficient number of surface inlet pits. For the overland system, the flood hazard reduction would be achieved through the incorporation of lower grade swales and rock protection of the steeper swales through the riparian corridors; and
- In general the flooding is contained within the assigned riparian corridor widths throughout the development. Further discussion on riparian corridors and corridor widths have been dealt with in the Ecological Assessment Report for Minmi and Link Road.

5.4.3 Evacuation Strategy

The management of floods and floodplains are the responsibility of State Emergency Service (SES) and Council. SES is mainly responsible for dealing with floods while flood planning and land management rest with Council.

The arrangements for managing flood prone land are detailed in the State Government's Flood Prone Lands Policy and the Floodplain Development Manual. The main considerations for the evacuation strategy are:

- The areas to be evacuated (namely areas within PMF flood extents);
- Number of people to be evacuated and the time available. At this stage, it is difficult to estimate the number of people;
- Muster areas and evacuation routes; and
- Resources and transport means necessary to meet these needs.

The most flood-affected properties are adjacent to the creek. Given the timing of flood peaks, evacuation will likely be required at short notice. The strategy and operations must be pre-planned during design stages. It is considered, that the site has sufficient space and locations to assemble and evacuate during flood events.

5.5 Consideration to Total Life Cycle Costs

GHD has proposed co-located bio-retention/detention basins in residential development areas to manage stormwater water quantity and quality. These systems achieve the following common goals:

- The treatment area is optimised;
- Total acquisition cost is minimised;

- The area could be landscaped without hindering its function; and
- Annual maintenance cost would be less compared to open water bodies such as wetland.

GHD has proposed a limited number of wetlands at selected locations to treat water quality, control the flood peak flows and to provide opportunity for stormwater reuse and habitat establishment. During the design process, a detailed total life cost analysis is recommended to justify these wetlands.

GHD has proposed vegetated swales at a number of locations. Vegetated swales are open channels system, which could be designed to treat water quality with low capital and maintenance costs. At this stage, any water quality treatments along arterial and local roads and at individual lots are not considered.

5.6 Ongoing Monitoring

Monitoring should be undertaken to ensure that stormwater quality management measures are working effectively. Monitoring would rely primarily on visual inspections and potentially sampling. Visual inspections should be undertaken for sediment traps, pits, diversions, GPTs, catch drains and all stormwater conveyance structures.

5.7 Water Demand Management and Reuse

Demand management should be maximised and could include water savings fittings, low flow showerheads, water efficient appliances, and low water demand toilets. Demand management would need to be implemented in order to meet the requirements of BASIX SEPP.

It is proposed that all buildings that have sufficient roof areas be provided with roof rainwater harvesting tanks. The rainwater tanks would overflow to the lot stormwater system and the road stormwater drainage system. Regional recycled water provision should be explored and maximised. The right combination between rainwater tanks and recycled water would need to be assessed further.

Stormwater harvesting should be promoted, in particular where the demands are located close to the storage location. In areas where sports fields are located close to wetlands and for the golf course, onsite storage areas could potentially be suitable. Wetlands are proposed near the town centres and playing field.

6. Conclusions

- A number of opportunities for management of stormwater quality, quantity and flooding exist at the Minmi and Link Road sites. This management would benefit from the implementation of Water Sensitive Urban Design (WSUD) practices. WSUD encompasses all aspects of urban water cycle management including water supply, wastewater and stormwater management, that promotes opportunities for linking water infrastructure, landscape design and the urban built form to minimize the impacts of development upon the water cycle and achieve sustainable outcomes
- A WSUD strategy for management of stormwater quality and quantity has been developed for the site that nominates:
  - On-lot treatment of stormwater quantity and quality, before discharge to the road stormwater system;
  - Vegetated swales along the identified main flow routes, consisting of open channel systems, which are used to remove sediment and suspended solids. They required width of the vegetated swales are approximately 6 m;
  - Precinct scale co-located detention/ bio-retention basins primarily upstream of road crossings over creeks to treat the quantity and quality of stormwater flows. These systems would essentially comprise a dry basin (to provide detention function) combined with bio-retention (to provide water quality treatment function) situated in the invert of the basin;
  - Gross pollutant traps and other structural measures, at critical locations as required, before discharge to the detention systems; and
  - Provision of rainwater tanks in all areas should be maximised in accordance with Council's requirements;
  - Habitable floor levels of new residences and, commercial developments located 500 mm above the flood level; and
  - For development in flood storage areas and flood ways development must not lead to a significant increase in flood levels, flood damages, flood behaviour or flood hazard at the site or elsewhere; and
  - Areas that are inundated by the PMF require a flood evacuation strategy. Elevated areas would provide suitable evacuation muster areas, of which it is considered there are sufficient throughout the precinct.
- The test the effectiveness of the WSUD strategy, numerical modelling was used as follows:
  - Flood peaks and flood levels for the creeks within the precinct were determined using RAFTS and TUFLOW;
  - Volumes of detention that responded as best possible to the Concept Plan and which throttled flood peaks were determined using RAFTS; and
  - Appropriate strategies for stormwater quality management throughout the precinct, which responded as best possible to the Concept Plan and which achieved the pollution load export requirements were determined using MUSIC.

The results of the numerical modelling has shown that the proposed WSUD strategy together with the flood plain management adequately satisfies the requirements of the NCC and LMCC DCP's and the

NSW Floodplain Development Manual for management of stormwater quantity, quality and flooding at the precincts.

Simulations for the 100-year future climate (2100) allowing for a 30% increase in rainfall intensity and volume have shown that in a 100-year ARI event, flood levels adjacent to the site are expected to increase by less than 0.3 m in the upper reaches. In the lower reaches where the creeks discharge to Hexham Swamp, the increase could be around 0.7m. While this does not cause a significant increase in flood extent, dwelling floor levels would need to consider these impacts, and be located above these flood levels.

The presence of numerous watercourses through the site has provided the opportunity to maximise the retention and designation of riparian corridors. The proposal seeks to encompass the intent of the Water Management Act where riparian corridors have been identified based on the stormwater conveyance and management requirements coupled with the desire to provide a diversity of habitat types for terrestrial and aquatic flora / fauna (further discussion on riparian corridors and corridor widths have been dealt with in the Ecological Assessment Report). The proposed riparian corridors widths allow for the conveyance of stormwater, management of water quality and flooding requirements, being cognisant of the topography and ecological value of the creeks. The Concept Plan identifies a range of buffer areas to creeks based on these corridor functions. In some instances the corridors are proposed to be rehabilitated and revegetated, improving bed and banking stability and reducing bank and channelling erosion. The enhancement of vegetation within these areas will therefore assist in protecting water quality by additional trapping sediment, nutrients and other contaminants as part of an overall comprehensive WSUD strategy. In general the flooding is contained within the assigned riparian corridor widths throughout the development.

7. References

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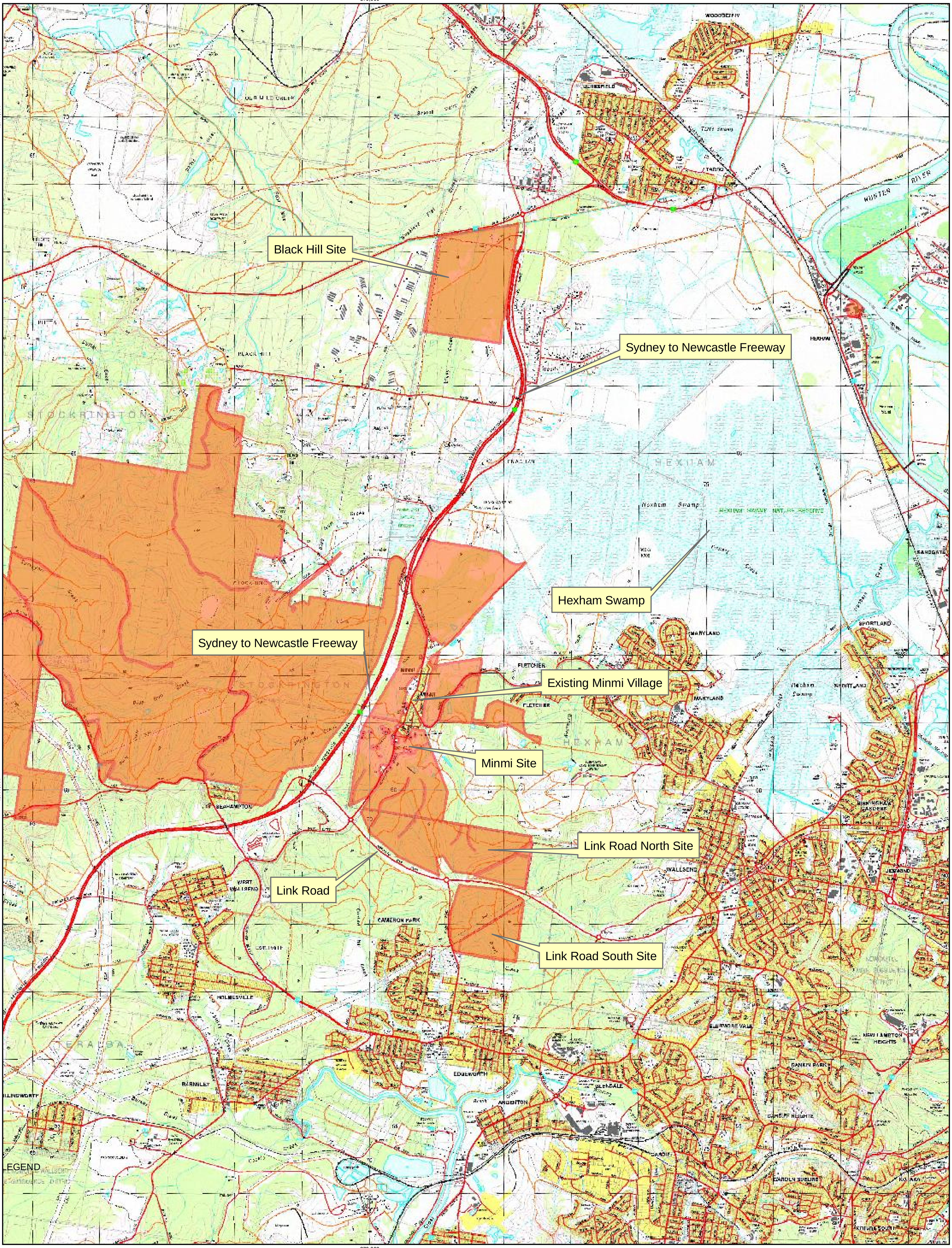
Appendix A

Site Location and Concept Plan



1:50,000

0 205 410 820 1,230 1,640 2,050

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

GHD

Legend

CA Land Holdings

Coal & Allied
Report for Lower Hunter Land
Project - Phase 2

Locality Map

Job Number	21-16058
Revision	Draft
Date	6 October 2008

Figure A.1

B:\Template\GHD-A3-PORTRAIT.mxt

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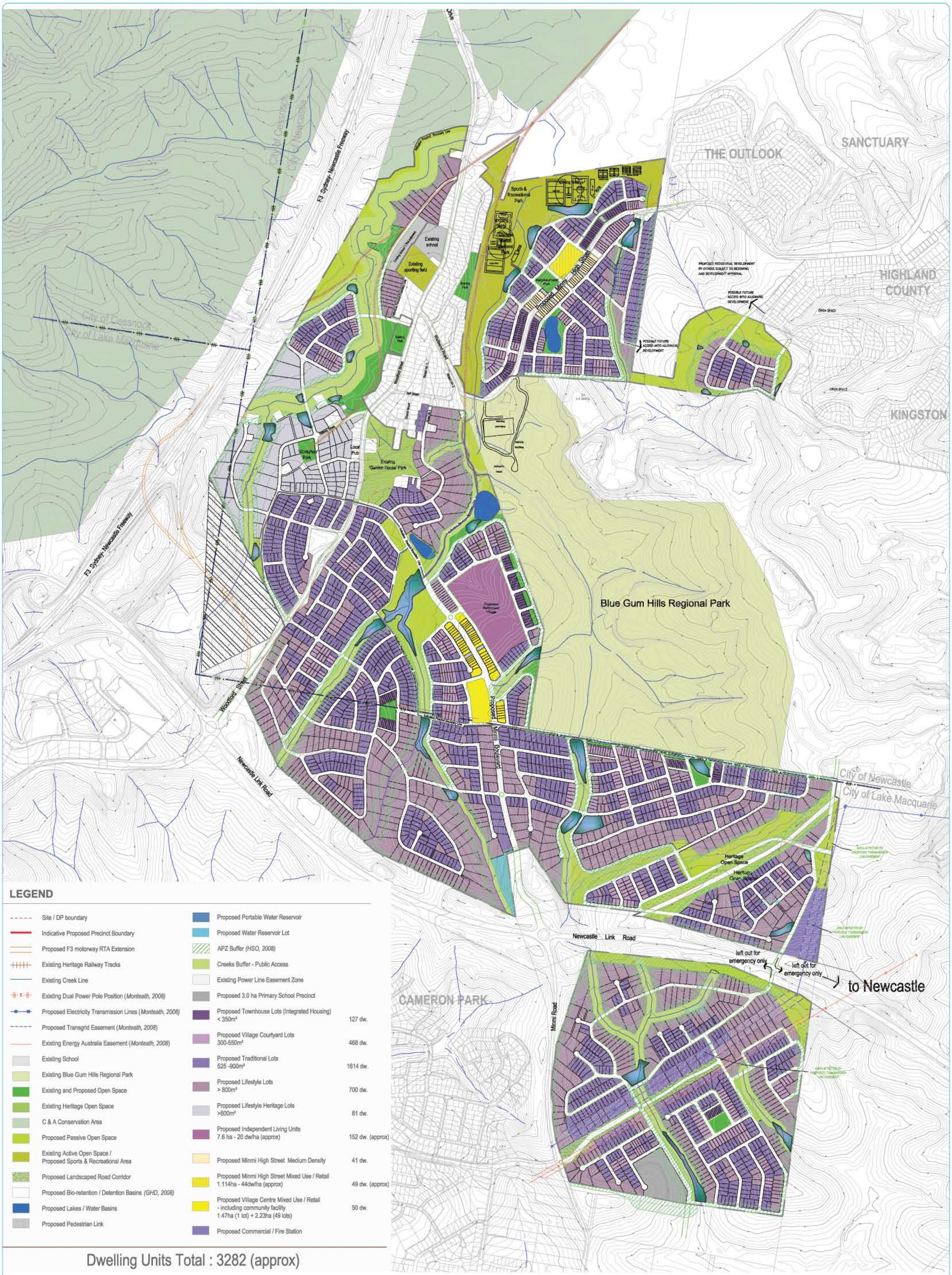
Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: R Berg



LEGEND

Site / DP boundary	Proposed Portable Water Reservoir		
Indicative Proposed Precinct Boundary	Proposed Water Reservoir Lot		
Proposed F3 motorway RTA Extension	APZ Buffer *(HSO, 2008)*		
Existing Heritage Railway Tracks	Creeks Buffer - Public Access		
Existing Creek Line	Existing Power Line Easement Zone		
Existing Dual Power Pole Position *(Monteath, 2008)*	Proposed 3.0 ha Primary School Precinct		
Proposed Electricity Transmission Lines *(Monteath, 2008)*	Proposed Townhouse Lots (Integrated Housing) < 350m²	127 dw.	
Proposed Transgrid Easement *(Monteath, 2008)*	Proposed Village Courtyard Lots 300-550m²	468 dw.	
Existing Energy Australia Easement *(Monteath, 2008)*	Proposed Traditional Lots 525 -900m²	1614 dw.	
Existing School	Proposed Lifestyle Lots > 800m²	700 dw.	
Existing Blue Gum Hills Regional Park	Proposed Lifestyle Heritage Lots >800m²	81 dw.	
Existing and Proposed Open Space	Proposed Independent Living Units 7.6 ha - 20 dw/ha (approx)	152 dw. (approx)	
Existing Heritage Open Space	Proposed Minmi High Street Medium Density	41 dw.	
C & A Conservation Area	Proposed Minmi High Street Mixed Use / Retail 1.114ha - 44dw/ha (approx)	49 dw. (approx)	
Proposed Passive Open Space	Proposed Village Centre Mixed Use / Retail - including community facility 1.47ha (1 lot) + 2.23ha (49 lots)	50 dw.	
Existing Active Open Space / Proposed Sports & Recreational Area	Proposed Commercial / Fire Station		
Proposed Landscaped Road Corridor			
Proposed Bio-retention / Detention Basins *(GHD, 2008)*			
Proposed Lakes / Water Basins			
Proposed Pedestrian Link			

Dwelling Units Total : 3282 (approx)

Note:

All dimensions and areas are approximate only, and are subject to survey and Council approval.

The boundaries shown on this plan should not be used for final detailed engineers design.

AMENDMENTS

DATE	DESCRIPTION	BY
20/01/09	- Revise street and lot layout - Revised heritage open space - Revised detention/bio-retention basin	MS

Level Datum	
Origin	
Scale	1:5000@A0
Date	20 January 2009
Surveyed	
Comp By.	SC/MS/ERF
DWG Name.	06083 CON3R
Local Authority	Newcastle/Lake Macquarie
Job Reference	06083

CLIENT

Coal & Allied

Indicative Concept plan

PROJECT

PROPOSED SUBDIVISION

Plan Reference

06083 CON3 R

CONICS

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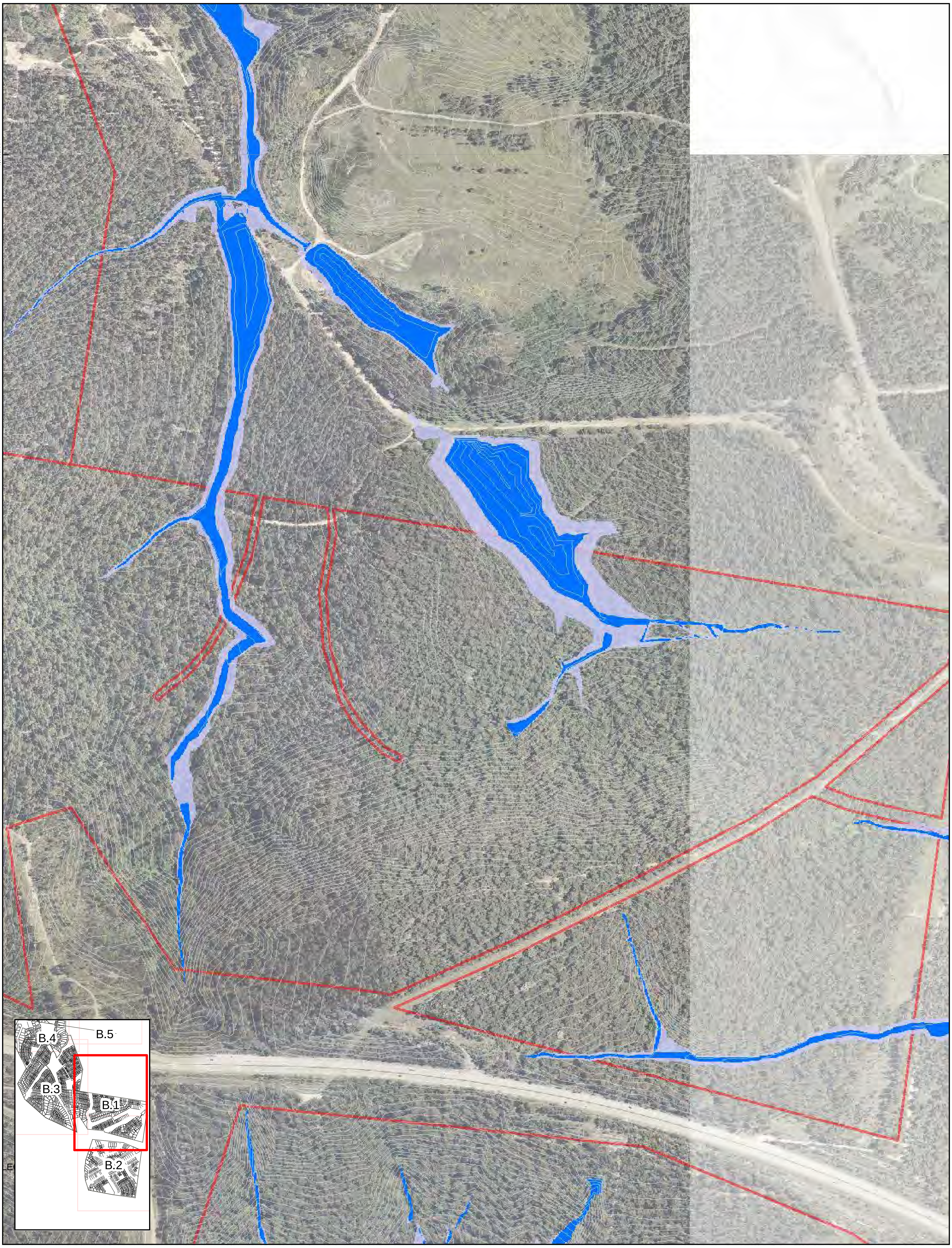
Appendix B
Existing Flood Maps



1:5,000

0 20 40 80 120 160 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

100yr ARI Flood Extents

PMF Flood Extents

Coal & Allied
Report for Lower Hunter Land
Project - Phase 2

Existing Flooding

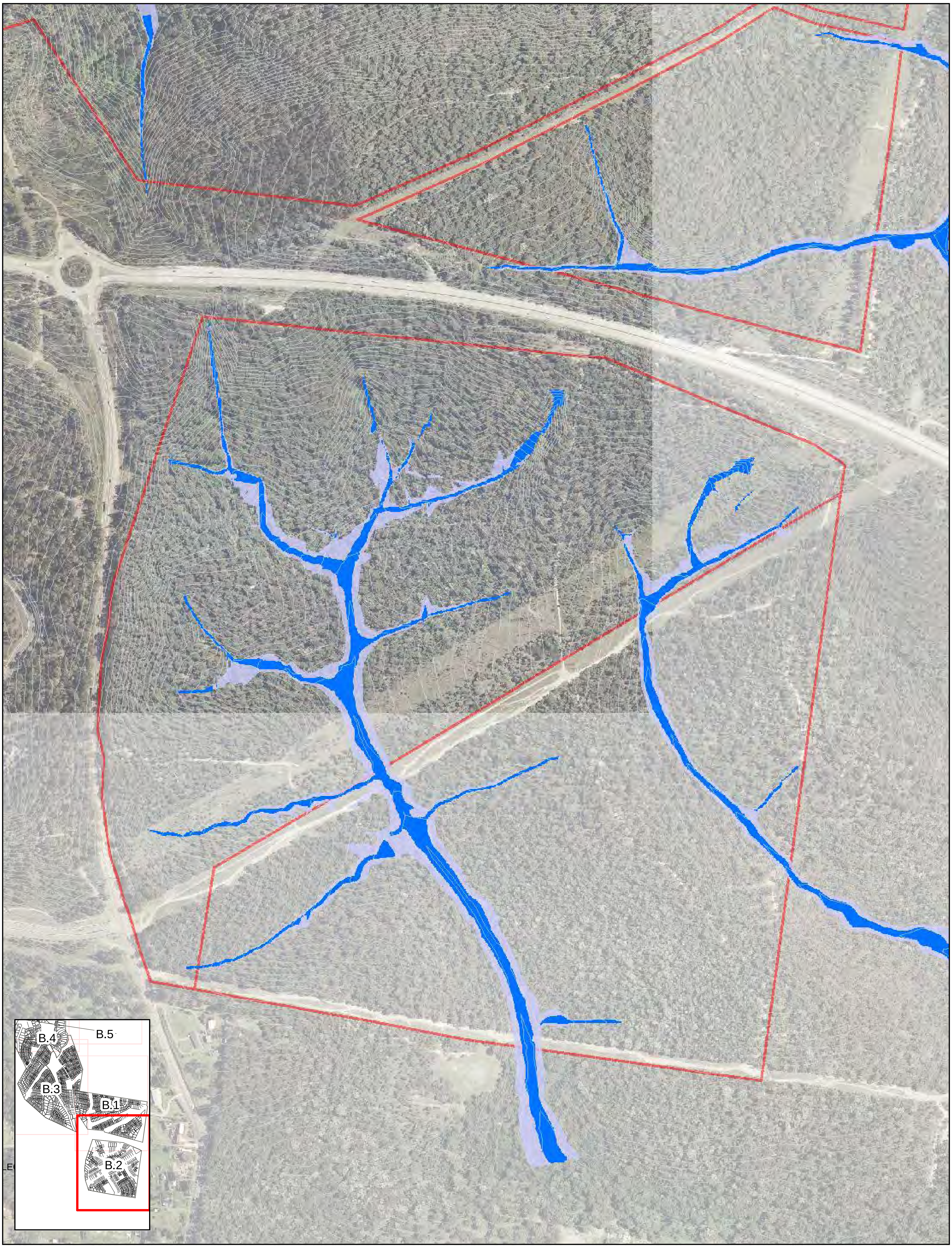
Job Number	21-16058
Revision	B
Date	6 October 2008

Figure B.1

B:\Template\GHD-A3-PORTRAIT.mxt

10 Bond Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: R Berg



1:5,000

0 20 40 80 120 160 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

100yr ARI Flood Extents

PMF Flood Extents

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Existing Flooding

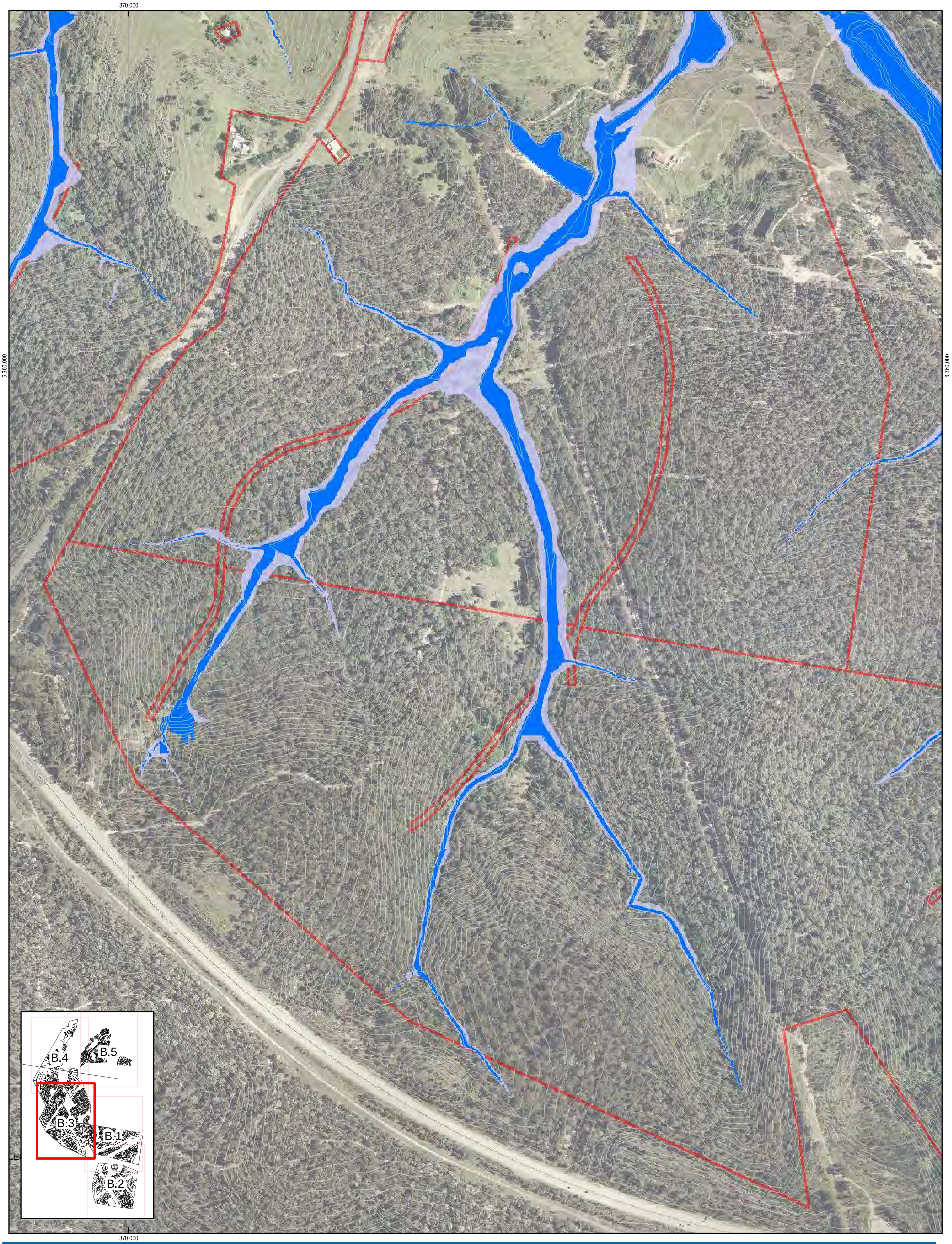
Job Number	21-16058
Revision	B
Date	6 October 2008

Figure B.2

B:\Template\GHD-A3-PORTRAIT.mxt

10 Bond Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: R Berg



1:5,000

0 20 40 80 120 160 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

O

100yr ARI Flood Extents

PMF Flood Extents

Coal & Allied
Report for Lower Hunter Land
Project - Phase 2

Existing Flooding

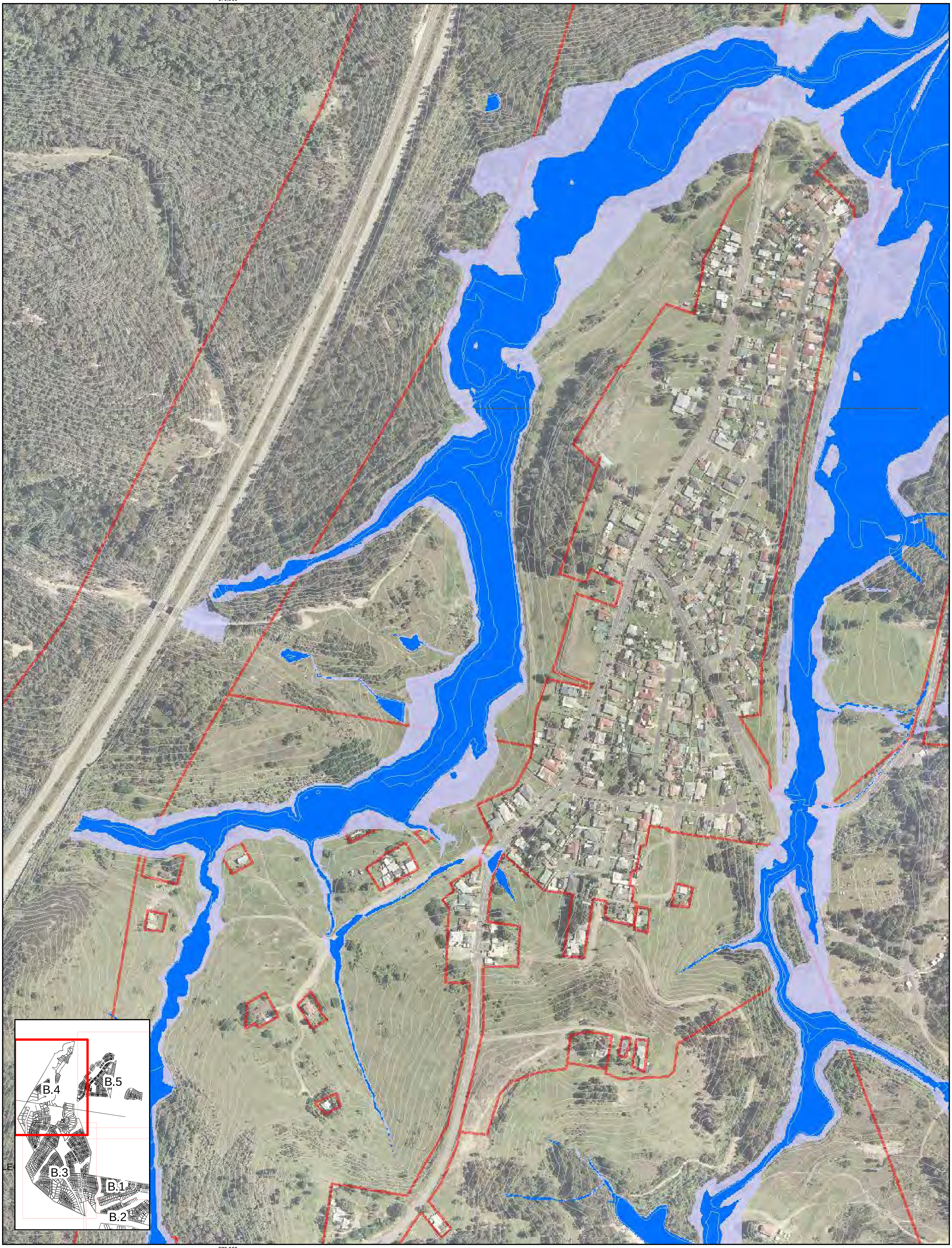
Job Number	21-16058
Revision	B
Date	6 October 2008

Figure B.3

B:\Template\GHD-A3-PORTRAIT.mxt

10 Bond Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: R Berg



1:5,000

0 20 40 80 120 160 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

100yr ARI Flood Extents

PMF Flood Extents

Coal & Allied
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Existing Flooding

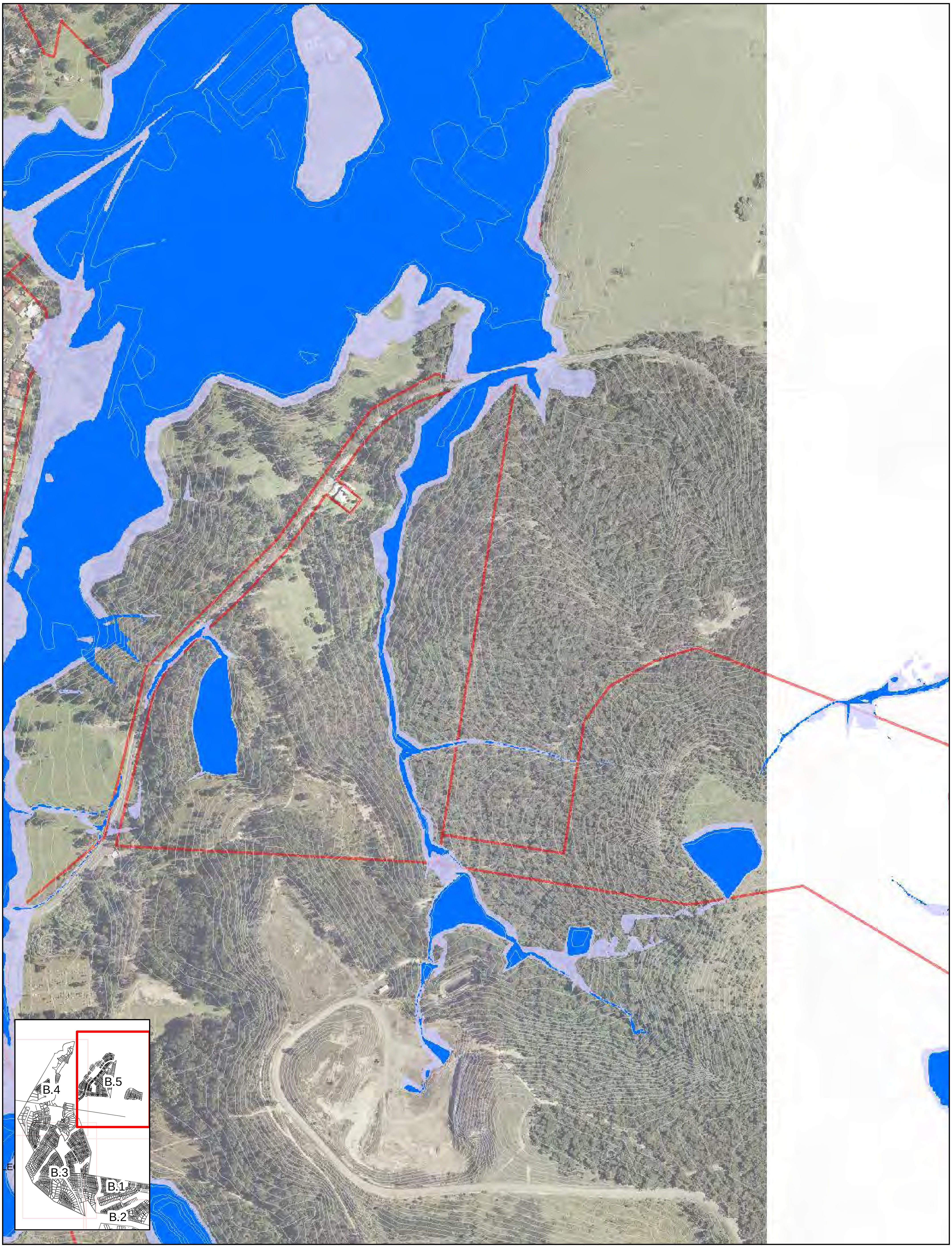
Job Number 21-16058
Revision B
Date 6 October 2008

Figure B.4

B:\Template\GHD-A3-PORTRAIT.mxt

10 Bond Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: R Berg



1:5,000

0 20 40 80 120 160 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

O

100yr ARI Flood Extents

PMF Flood Extents

Coal & Allied
Report for Lower Hunter Land
Project - Phase 2

Existing Flooding

Job Number	21-16058
Revision	B
Date	6 October 2008

Figure B.5

B:\Template\GHD-A3-PORTRAIT.mxt

10 Bond Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: R Berg