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Coal & Allied Industries Limited

Report for Lower Hunter Lands Project

Black Hill and Tank Paddock: Water Sensitive Urban Design, Flooding and Stormwater Management

January 2011

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

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1. Introduction

1.1 Background

It is proposed that the entire Coal & Allied Industries Limited (Coal& Allied) owned Black Hill and Tank Paddock sites be rezoned/listed as a 'State Significant Site' (SSS) in Schedule 3 of State Environmental Planning Policy (Major Development). A draft Schedule 3 listing will be prepared with the Concept Plan Application.

The Concept Plan will apply to the entire 183ha Black Hill, the 147ha Tank Paddock site and 398Ha of the Stockrington site. The key parameters for the future development of the sites are as follows:

» Dedication of 545ha of conservation land to the New South Wales Government (NSWG) that is identified in the Lower Hunter Regional Strategy and Lower Hunter Regional Conservation Plan, comprising 100% of the 147ha Tank Paddock site and 398ha of the Stockrington site.

» Use of the 183ha Black Hill site as 'employment lands' for a range of employment generating activities.

» Indicative development staging - The number of lots and extent of staging for release areas will be largely dictated by the service infrastructure requirements as well as responding to market forces.

» The provision of associated infrastructure.

Approval will not be sought under the Concept Plan for a specific lot or road layout. An indicative super-lot layout will be prepared, which will indicate how subdivision could be achieved that will enable a range of industrial and ancillary activities to be undertaken.

An existing mining consent under the Black Hill site will defer development on the site until post June 2013. Accordingly, a detailed built form layout has not been prepared at this stage. Approval is not sought under the Concept Plan for subdivision or for individual buildings on the site. Urban Design Guidelines will be prepared to inform the Concept Plan in respect of urban form, built form, open space and landscape, access and movement and visual impact for the site.

It is proposed to dedicate land for conservation purposes as part of the Major Project Application via a Voluntary Planning Agreement (VPA) between Coal & Allied and the NSWG in accordance with s.93F of the Environmental Planning & Assessment Act, 1979 (EP&A Act).

This report supports the Concept Plan application, addressing Water Sensitive Urban Design, Flooding and Stormwater Management for the proposed site, shown in the Concept Plan in Appendix A.

1.2 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). 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 and altered/increased pollutant loads, potentially impacting sensitive downstream habitats in terms of flushing regimes (frequency, volume and rate) 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 precinct scale 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 Black Hill site topography.

2. Existing Conditions and Derived Constraints

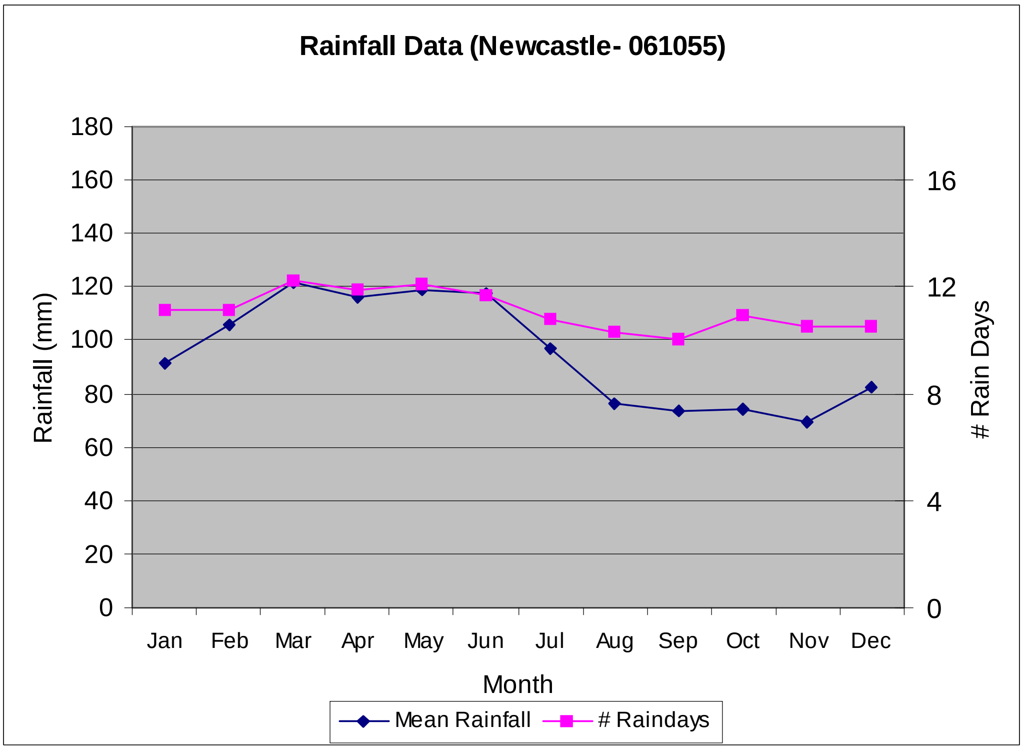
2.1 Climate and Rainfall

The Black Hill development site experiences a sub-tropical climate with rainfall predominantly occurring in late summer and autumn. The nearest 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 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 may 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. The site generally slopes towards the northwest. Overall, it has mild to moderately undulating slopes with areas of significant disturbance, including an operating asphalt plant, electricity easement and past clearing.

Areas of steeper slopes (greater than 5%) generally do not suit WSUD facilities such as bioretention swales. In such cases, 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 Black Hill site is underlain by two soil landscape groupings:

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

» *Shamrock Hill Landscape* underlies some of the land at the northern extent of the site. The limitations of this soil group include high susceptibility to water erosion, highly acidic, low fertility soils and localised steep slopes.

The limitations of the soil groups and propensity to erosion would need to be considered when planning WSUD facilities. Ground water aspects are dealt with in a separate groundwater report, and WSUD facilities relying on infiltration may need to be lined to prevent contamination of ground water..

2.4 Watercourses, Creeks, Riparian Corridors and Receiving Waters

Viney Creek flows through the site from south to north, bisecting the site. Viney Creek flows under John Renshaw Drive and discharges into Woodberry Swamp, a wetland system of the Hunter River estuary. A smaller creek drains along the western boundary of the site, also draining under John Renshaw Drive.

The geomorphic features of Viney Creek appear relatively in tact. However, there are areas of disturbance such as at a crossing constructed for maintenance of the electricity infrastructure within the easement. The crossing acts as a small weir, pooling water upstream. The channel is widened in this location and there is significant invasion by weed species.

In terms of riparian corridors, the requirements of the Water Management Act are noted, and while the proposal seeks to encompass the intent of the Water Management Act, under Part 3A of the EP & A Act this piece of legislation is not triggered. Adequate setbacks have been proposed that cater for the proposed hydrological / drainage requirements while making due consideration to the existing ecological character of creeks.

In terms of riparian corridors, the requirements of the Water Management Act are noted, and while the proposal seeks to encompass the intent of the Water Management Act, under Part 3A of the EP & A Act this piece of legislation is not triggered. Adequate setbacks are proposed for the site , which will cater for the proposed drainage requirements while making due consideration to the existing ecological character of the gullies

2.5 Adjoining Land Uses

An asphalt plant operated by Boral is active within the site on land leased from Coal and Allied. A light industrial business park, partly still under construction, lies to the north and northeast, separated from the site by John Renshaw Drive. To the west is a disused poultry farm and to the east is rural residential development, separated from the site by the Newcastle-Sydney Freeway. Existing rural lots are located to the south.

2.6 Mining Subsidence

Abel Mine have provided estimates of future subsidence at the Black Hill site, in particular Viney Creek and the western tributary, (Subsidence predictions SMP Area 1.pdf" Figure 3: "Predicted Worst Case Mining Subsidence Contours"). These were investigated in terms of flooding impacts.

2.7 Key Statutory Requirements

In addition to the statutory requirements under the Part 3A of the *Environmental Planning and Assessment Act 1979 (EPA & Act)* process, the discipline specific guidelines relating to Water Sensitive Urban Design, Flooding and Stormwater Management which should be considered include:

- 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 prioritise investment in natural resource management for this area;
- NCC LEP (2003) and Development Control Plan 2005 - guides development across the Newcastle LGA, notably in the areas of flood and water management,
- The Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000; and
- NSW Floodplain Development Manual, 2005 - which outlines guidelines relating to floodplain management.

3. Design Criteria and Supporting Simulations

3.1 Design Criteria and Environmental Objectives

3.1.1 Stormwater Quality

NCC guidelines nominate target maximum event mean concentrations for a range of pollutants for developments as indicated in Table 1 below. The hydrocarbon and ammonia targets are not readily simulated in MUSIC, and these targets do not take into consideration site-specific effects and base load concentrations.

Table 1 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

DECCW worked alongside the Growth Centres Commission to specify stormwater pollutant targets for many developments in Western Sydney as shown in Table 2, which aim to mitigate the effects due to developments.

Table 2 Growth Centres Development Code Stormwater Targets

	% of Reduction
Total SS (kg/yr)	85
Total Phosphorus (kg/yr)	65
Total Nitrogen (kg/yr)	45
Gross Pollutants (kg/yr)	90

More recently DECCW have been reviewing the Growth Centres Development Code targets and are about to issue revised guidelines (already available in draft). In GHD's experience, the Growth Centre Guidelines are rigorous, readily simulated in MUSIC and effective in managing stormwater quality runoff from developments. We thus nominate the use of these guidelines for this project at this planning stage.

3.1.2 Stormwater Quantity and Flood Risk

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 sites (currently being compiled):

- Stormwater management measures are to be installed within the public domain area (including easement under Council control) and such are to be sized on the assumption that 60% of new road reserve areas plus 20% of allotment areas is impervious. Since this will be a industrial development, allotments will be have a higher percentage of impervious area;
- 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.

Since the DCP addresses residential developments, GHD contacted NCC who confirmed that the same should be applied to industrial development. Development and land-use in flood prone areas should be in accordance with NCC Flood Management Technical Manual and the NSW Floodplain Development Manual.

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

		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

3.2 Supporting Simulations

Numerical modelling was used to assess the existing flood risk and evaluate the proposed stormwater quantity and quality management system. This modelling allowed an assessment of:

- Existing conditions flood peaks and flood levels for the creeks across the site and future climate change and mining subsidence impact, for a range of design storm events (using XP -RAFTS and HECRAS);
- Appropriate volumes and strategies for detention throughout the site, that responded, as best possible, to the concept plan and which controlled post development flows (using XP-RAFTS); and

» The performance of stormwater quality strategies to be incorporated which would mitigate impacts from the development (using MUSIC) and which achieved the pollution load export requirements set by Council.

All modelling should be considered as preliminary for the purposes of planning and a more detailed investigation will be required as the project progresses to a more detail design phase.

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 -Frequency -Duration (IFD) determination for generating storm rainfall events.

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 in response to the concept plan; and

» Developed conditions with required volume of detention, to mitigate increased flood peaks on account of the development. To determine the volume of detention, the RAFTS model was updated to include precinct scale detention storage facilities. The RAFTS catchments were configured to include 60% impervious road reserves and 20% impervious lot areas. This is based on the NCC DCP requirement that on-lot detention will be required in addition to the precinct structures. Simulations were undertaken for the 10- and 100-year ARI event, since satisfying these two events generally provides the maximum storage requirements.

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

» Industrial = 90%; 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 ARI and PMF Flood Levels and Climate Change Effects on Flooding

Flooding in Viney Creek and associated tributaries 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 boundary conditions in the form of flood levels were determined by adopting flood levels downstream on John Renshaw Drive based on normal flow conditions.

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.

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. 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 RAAF base 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 region.

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 1023 mm/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 1732 mm/year.

In pursuing WSUD, Newcastle City Council is 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 Viney Creek and the Woodberry Swamp.

3.3 Climate Change

The DECCW Practical Consideration of Climate Change, October 2007 guidelines recommend that the following sensitivity analyses be undertaken in relation to the climate change impacts on rainfall intensities. It recommends assessment of increases of rainfall intensities considering:

» 10% increase in peak rainfall and storm volume;

» 20% increase in peak rainfall and storm volume; and

» 30% increase in peak rainfall and storm volume.

For Viney Creek the 30% increase in storm rainfall intensity and storm volume was adopted. This was considered an upper envelope of climate change for a 2100 planning horizon. On this basis, the RAFTS and TUFLOW models were resimulated.

3.4 Mining Subsidence

The following methodology was used to assess impacts of subsidence on flooding at the site:

» The subsidence contours received from Abel Mine were digitised into the terrain modelling software package 12D. Using 12D these contours were converted to a grid of points, each containing the estimate of subsidence;

» The TUFLOW 100-year ARI event flood model was modified such that the above grid of points were subtracted from the existing topographic grid

» The TUFLOW 100-year ARI event flood model for post-subsidence conditions was simulated; and

» The results were compared to pre-subsidence simulations. The pre-subsidence flood levels were subtracted from the post-subsidence flood levels to determine the flood level difference contours. These contours were then overlain over the flood extent comparison to produce the attached map.

To check that the modelled post-subsidence ground levels were correctly interpreted by TUFLOW, the two grids were compared and were found to equate to the subsidence contours, as required.

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. Ground water aspects are dealt with in a separate groundwater report.

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 Black Hill site is located in an area that is sparsely populated with significant aesthetic amenity and potential receiving environments.

NCC is acutely aware of the need to maintain the health of the natural environment and has 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 Black Hill site 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 management plan to achieve the above will also consider flood management, flow management, water quality management and flow attenuation.

5.1.3 Opportunities

General opportunities for WSUD at the Black Hill site include:

- » 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.

5.1.4 Creeks and Site Discharge Points

The presence of Viney Creek and watercourses at the site provides 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 buffer areas to Viney Creek 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 of 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.

The site topography results in two discharge points corresponding to existing drainage corridors, under John Renshaw Drive. Stormwater runoff would be controlled within the precinct in accordance with Council’s requirements prior to discharging from the site. This applies to both stormwater quantity and quality.

5.1.5 Strategy Drivers

The proposed WSUD strategy for the Black Hill site is provided in Appendix C. A number of specific “drivers” were identified, which have guided the Black Hill WSUD strategy development including the following.

- Requirements of the relevant Council DCP’s.
- The industrial 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; and
  - Favours precinct scale for road runoff, using swales and basins.
- The site topography:

- – Favours management of stormwater upstream of the discharge point of Viney Creek under John Renshaw Drive.
- » The flatter site topography in the lower reaches:
  - – Favours larger a co-located bioretention and detention basin.

5.2 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;
  - – Swales & other landscape measures;
  - – Sand/gravel filters for runoff from car parks and driveways; and
  - – Reducing the area of paving; and
- » 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
  - – A number of bioretention/detention basins are proposed throughout the site discharging to the riparian corridor. The basins would provided both detention and water quality treatment function. The bio-retention basins may need to be lined to prevent contamination with groundwater;
- » 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.

To test the effectiveness of the proposed strategies, a MUSIC model was developed to represent the developed conditions. The results for the site, listed in Table 5, show a decrease in total suspended solids, phosphorous, nitrogen and gross pollutants as a result of incorporating the appropriate WSUD treatment measures. From the table it can be seen that the incorporation of WSUD treatment measures achieves the nominated targets. The additional net benefit of the inclusion of WSUD measures is a reduction of the existing pollutant load as a direct result of the proposed development.

Table 5 Stormwater Treatment Measure Effectiveness

	Existing (kg/yr)	**Post-development (with WSUD) (kg/yr)**	**% Reduction using WSUD**	**Target Pollutant Removal Efficiency**
Total Suspended Solids	282000.00	15600.00	95	85
Total Phosphorus	578.00	105.00	82	65
Total Nitrogen	4010.00	1950.00	51	45

	Existing (kg/yr)	Post-development (with WSUD) (kg/yr)	% Reduction using WSUD	Target Pollutant Removal Efficiency
Gross Pollutants	40700.00	646.00	98	90

5.2.1 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.

5.3 Flooding and Stormwater Quantity Management

5.3.1 Detention

- Detention will be provided on individual lots, before discharge to the street drainage system. This can be achieved using tanks, basins, landscape measures and/or detention zones in rainwater tanks;
- Precinct scale detention basins are proposed upstream of John Renshaw Drive together with smaller basins located throughout the site discharging to the riparian corridor. 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 at each site. 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 and simulated. In general it was found that a minimum required on-site detention storage of approximately 140 m^3/ha (assuming 75% of the catchment is impervious) together with a minimum precinct scale detention basin of approximately 330 m^3/ha would be required.

The required detention storage for the off-site portion equates to approximately 3.5% of the developed footprint, however additional land (up to 5% in total) may need to be provided to allow for embankments and local landscaping associated with these basins. 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 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 6 shows the effectiveness of the detention strategy in reducing the 10-year and 100-year ARI post development flows to the predevelopment levels. The table shows favourable agreement of existing discharges with developed mitigated discharges. During the detail design stage, the post developed flows for the more frequent ARI storm events can be further throttled using staged outlets.

Table 6 Effectiveness of Detention Strategy

Storm Event Duration	Existing – 10 Year ARI (m^3/s)	Developed with mitigation – 10 year ARI (m^3/s)	Existing – 100 Year ARI (m^3/s)	Developed with mitigation – 100 year ARI (m^3/s)
25 min	4.19	5.28	15.06	15.80
45 min	10.11	11.11	26.44	26.0
1 hr	13.49	14.50	32.19	31.90
1.5 hr	18.19	19.47	39.34	39.34
2 hr	20.96	21.88	43.69	40.98
3 hr	23.76	25.48	45.48	40.92
4.5 hr	24.40	26.26	45.22	40.82
6 hr	26.90	28.73	50.35	40.96
9 hr	35.04	35.66	57.33	40.30

5.3.2 Flooding and Flood Risk

Flood maps are provided in Appendix B. In general, the results show:

» Figure 1: A significant floodplain associated with Viney Creek and the Western Northern Tributary;

» Figure 1: John Renshaw Drive results in some backwater effect in a 100-year ARI event and more frequent events; and

» Figure 1: The PMF flood extents are significantly larger in flood extent compared with the 100-year ARI flood extents due to the flatter terrain.

Development and land use in flood prone areas should be in accordance with the NCC Flood Management Technical Manual 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 together with normally occupied floors of special use developments should either be at or above the Flood Planning Level (500mm above the 100-year ARI event flood 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.

For the Black Hill development site, all floor levels 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 with a freeboard of 500 mm above 100-year ARI flood levels, considering climate change.

Referring to Appendix C, 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 the 100-year ARI event extends into the development footprint. In these locations, minor filling of the flood fringe could 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.

5.3.3 Climate change and Flooding

The impacts of the climate change scenarios are shown in Appendix B, Figures 2 and 3. In general the figures demonstrate the following;

- Figure 2: Flood extents in the 100-year ARI climate change scenario increase by a small amount on account of climate change; and
- Figure 3: 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. While this does not cause a significant increase in flood extent, floor levels would need to consider these impacts.

5.3.4 Mining Subsidence and Flooding

The impacts of mining subsidence scenarios are shown in Appendix B, Figures 4 and 5. In general the figures demonstrate the following

- It can be seen that the subsidence results only in minor increases to the flooding extents as most of the land inundated by the 100-year ARI event and the PMF is not subject to subsidence;

- For the western tributary, the shape and levels in the natural channel are altered by the subsidence. As such the flood extents and levels along this creek vary from the pre-subsidence flooding conditions; and
- At two locations on the eastern bank of Viney Creek, the flood extents increase in the 100-year ARI event due to the lowering of the ground level through subsidence. This results in lower floodplain grades which increases inundation extent; and
- At one location where a small tributary joins Viney Creek from the west, the flood levels and extents vary due to subsidence altering the natural channel shape and levels.

A typical cross-section through the creeks is provided in Appendix B, Figure 6.

5.3.5 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 within PMF flood extent to be evacuated;
- 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, and access to hospitals.

The most "at risk" properties are adjacent to the Viney 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.

5.4 Total Life Cycle Costs

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

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

GHD has proposed a limited number of basins 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 systems.

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.

5.5 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.

5.6 Water Demand Management and Reuse

To address Integrated Water Cycle Management, potable water conservation could be achieved by:

- Demand Management; and
- Substitution using fit for purpose principals.

Potable water conservation could lead to wastewater flow reduction, which leads to benefits to the environment in terms of reduced treated discharges. In addition roof and stormwater harvesting would reduce discharge to the environment when used in fit-for-purpose substitution. 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 .All sites that have sufficient roof areas could be provided with roof rainwater harvesting tanks. The rainwater tanks would overflow to the site sub-surface stormwater system and the road stormwater drainage system.

6. Conclusions

A number of opportunities for management of stormwater quality, quantity and flooding exist at the Black Hill site. 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, which 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. The required width of the vegetated swales is approximately 6 m;

» A number of detention/ bio-retention 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. The bio-retention system would potentially need to be lined in areas to prevent contamination of groundwater;

» 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;

» Floor levels 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.

» 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. While this does not cause a significant increase in flood extent, flood planning levels would need to consider these impacts; and

» Assessment of mining subsidence impacts on flooding, show that while the 100-year ARI event flood extents do not increase significantly, and the 100-year flood levels are similar to pre-subsidence conditions, the floodplain adjacent to the creek could be lowered. Therefore to satisfy flood planning levels, floor levels may need to be raised in some instances.

The test the effectiveness of the WSUD strategy, numerical modelling was used as follows:

» Flood peaks and flood levels for existing, future climate and subsidence scenarios for the creeks within the site 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 Water Sensitive Urban Design strategies for stormwater quality management throughout the precinct, which responded as best possible to the Concept Plan and which achieved Council's pollution load targets 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 DCP and the NSW Floodplain Development Manual for management of stormwater quantity, quality and flooding at the precincts.

7. References

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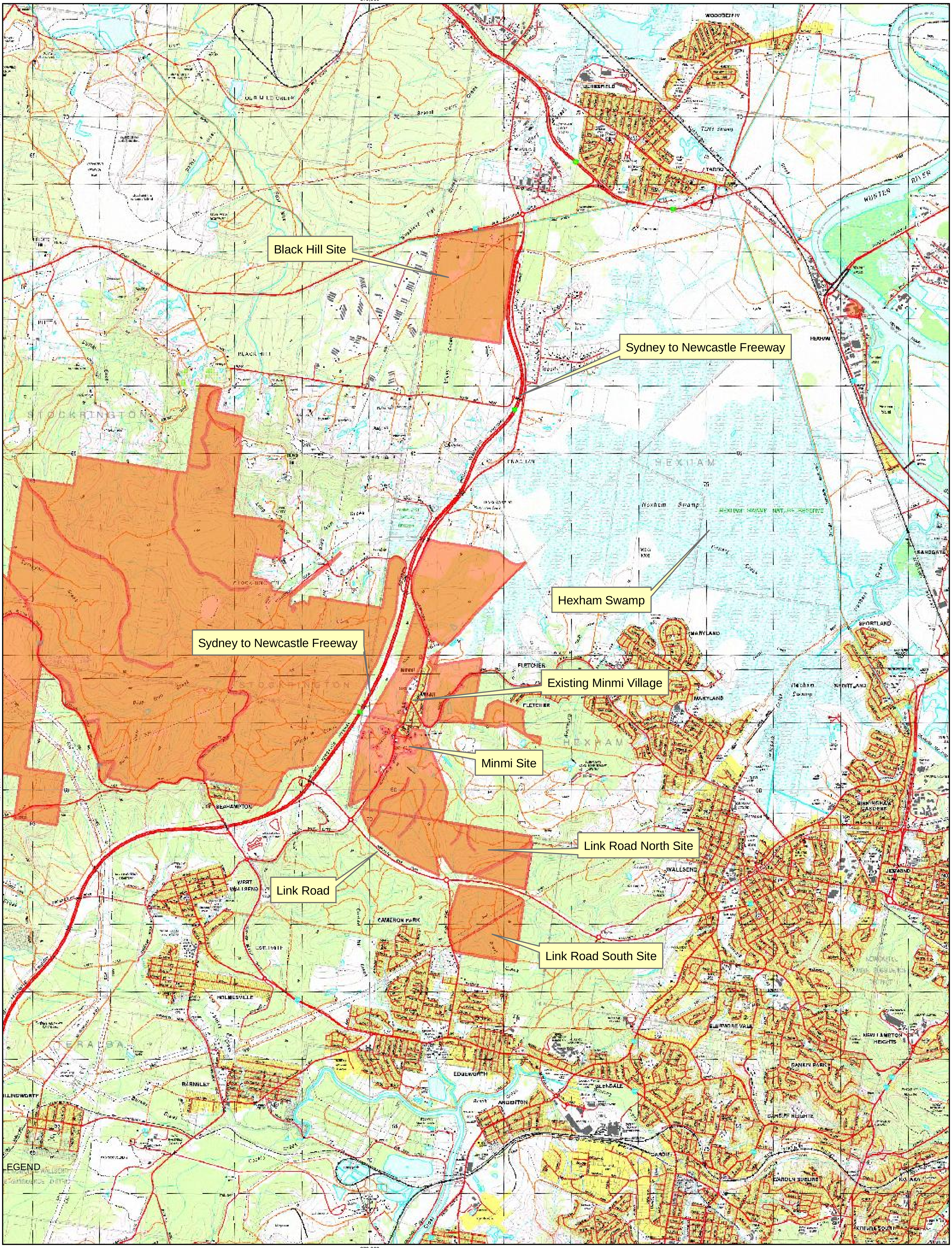
- DECCW, Practical Consideration of Climate Change, October 2007.

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

Legend

CA Land Holdings

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

Job Number	21-16058
Revision	Draft
Date	6 October 2008

Locality Map

Figure A.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

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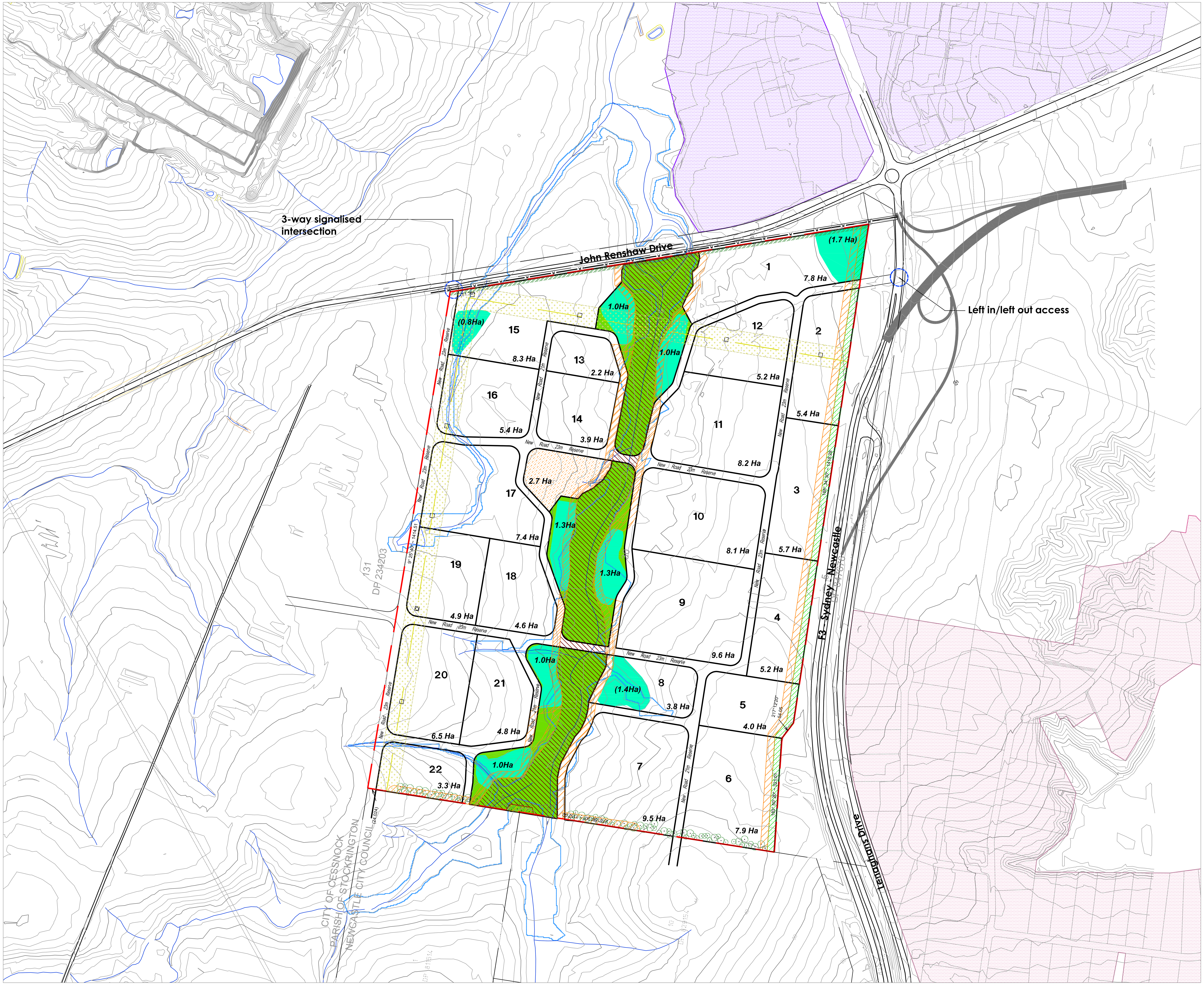

LEGEND

- Site Boundary
- Existing Creek Line
- Existing Hunter Water Pipeline
- Existing Residential
- Existing Industrial
- Indicative Stancheon Locations
- Proposed Powerline Easement
- Proposed Detention Basin
- Indicative Proposed Riparian Zone
- Indicative Proposed APZ - 20m
- Proposed 20m wide Green Buffer Zone *(as required under Newcastle - Lake Macquarie Western Corridor Planning Strategy)*
- Indicative Proposed F3 Freeway - Raymond Terrace Interchange
- Proposed Indicative Site Entries
- Proposed Visual Buffer
- Proposed 10m wide Visual Buffer to John Renshaw Drive.
- 100 Year ARI
- Support Facilities
- Public Open Space

Land Budget
26ha Proposed Public Open Space
157ha Developable Land incl. Lots, Road, Easements, Buffers, APZ's, Detention basins

Scale: 1:5000 @A1

24391-03
Indicative Concept Plan