CESSNOCK CITY COUNCIL

CESSNOCK
DEVELOPMENT CONTROL PLAN 2010

PART E
SPECIFIC AREAS

E.13: CESSNOCK CIVIC

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E.13: CESSNOCK CIVIC

LIST OF FIGURES

13.1 INTRODUCTION

This chapter provides guidelines for the development of Lots 21, 22 & 23 DP 845986, Lot 1 DP 103630, Lot 251 DP 606348, Lots 1, 2 & 3 DP 608084, and Lot 7300 DP 1143010 off Vincent Street, Cessnock known as the ”Cessnock Civic Precinct”.

The subject land is located immediately south of the Cessnock City Centre and is approximately 61.6 hectares in size. The site is bounded by an Energy Australia substation and low scale commercial uses to the north, residential housing to the east, Crown and privately owned land to the south and residential land to the west. Black Creek traverses the site in a north and north-westerly direction.

Much of the site has been highly modified as a result of past underground and open cut mining activities associated with the Aberdare Extended Colliery, which operated up until 1965. The past mining activities have left a legacy of potential mine subsidence issues in parts of the site.

Proposed land uses on the site will include bulky goods, commercial and service business land along Vincent Street and in the centre of the site; environmental conservation lands to the south and the retention of the rural zoning on the remainder of the site until further detailed investigations are undertaken.

OBJECTIVES

The principal objectives of this Chapter are:

(a) To provide for a range of bulky goods, commercial and service business developments that support the higher order function of the adjacent Cessnock City Centre.

(b) To achieve high quality development which has regard to the visual prominence of the land through the use of appropriate architectural elements, quality materials and finishes.

(c) To provide guidelines which protect the amenity of the adjacent residential properties through appropriate building setbacks, built form and landscaping.

(d) To protect and enhance native vegetation within the E2 Environmental Conservation zone and riparian area of Black Creek.

(e) To provide guidelines which detail the methods in which mine subsidence, flooding and drainage issues are to be managed on the site.

(f) To establish appropriate pedestrian and vehicular access to and within the site.

13.1.1 Application

This Plan is called Cessnock Civic and forms part of the Cessnock City Wide Development Control Plan 2010. The Plan consists of the written statement and plans referred to in the document.

Figure 1 details the land to which the Plan applies (shown edged heavy black) and the land use zones applying to the site.

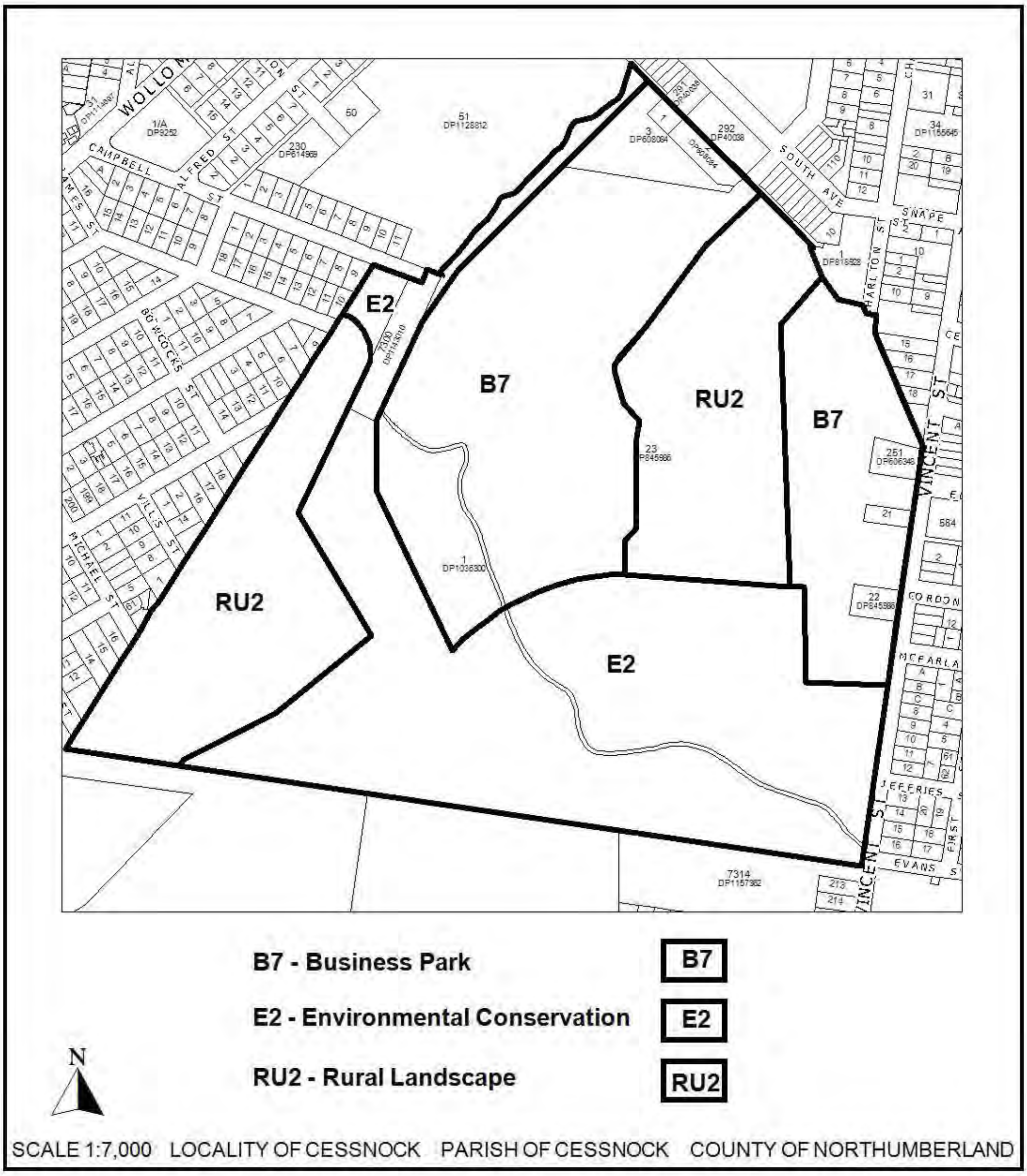

Figure 1 – Site and Zoning Plan

This Plan (chapter) was adopted by Council on 21 March 2012.

13.1.2 Purpose of the Plan

The purpose of the Plan is to give detailed guidance for development within the area. It provides more detailed provisions than those contained in the Cessnock Local Environmental Plan (LEP) 2011 and more locally specific provisions than the Cessnock Development Control Plan 2010.

Council will take into account the provisions of this Plan in determining development applications. Council may consent to an application which departs from the provisions.

Where applications seek to depart from the provisions of this Plan, they should be accompanied by a written justification.

13.1.3 Relationship with other Plans

Where there is any inconsistency between this Plan and any environmental planning instrument, the provisions of the environmental planning instrument prevail. An environmental planning instrument includes a State Environmental Planning Policy (SEPP), a Regional Environmental Plan (REP) and a Local Environmental Plan (LEP).

This chapter should be read in conjunction with all chapters and sections of the Cessnock Development Control Plan 2010 and any other relevant Council policies. A number of other chapters are applicable to the site (e.g. parking and access and industrial development) and in some instances the provisions of those chapters are supplemented by additional guidelines in this locality specific chapter.

13.1.4 Cessnock City Wide Settlement Strategy

The subject site was included within the City Wide Settlement Strategy 2010 (CWSS) as land supporting the regional centre (i.e. Cessnock City Centre).

Cessnock Civic is identified in the CWSS as being ideally located in proximity to the Cessnock commercial precinct, to complement existing retailing activity through the development of bulky goods retailing. The B7 Business Park zone will also provide for limited commercial opportunities and light industry support.

13.2 PLANNING CONSIDERATIONS

- ***13.2.1 Detailed Development Considerations*** relating to the management of mine subsidence, flooding and drainage, and traffic, which have required extensive investigation and reporting.
- ***13.2.2 General Development Considerations*** which address broader planning issues relating to subdivision layouts and staging, residential amenity issues, built form, bushfire and environmental management.

13.2.1 General Development Considerations

A LEP and Preferred Subdivision Plan

The zoning plan and the preferred indicative subdivision plan are provided in **Figure 1** and **Figure 2** respectively.

The land is affected by a number of land use zones. The zones are as follows:

- Zone B7 Business Park
- RU2 Rural Landscape (shown in the figure below under its former zoning of 1(a) Rural “A” Zone under the Cessnock Local Environmental Plan 1989)
- Zone E2 Environmental Conservation.

Any development proposed within the land must have regard for the requirements of the zone pursuant to Cessnock Local Environmental Plan 2011.

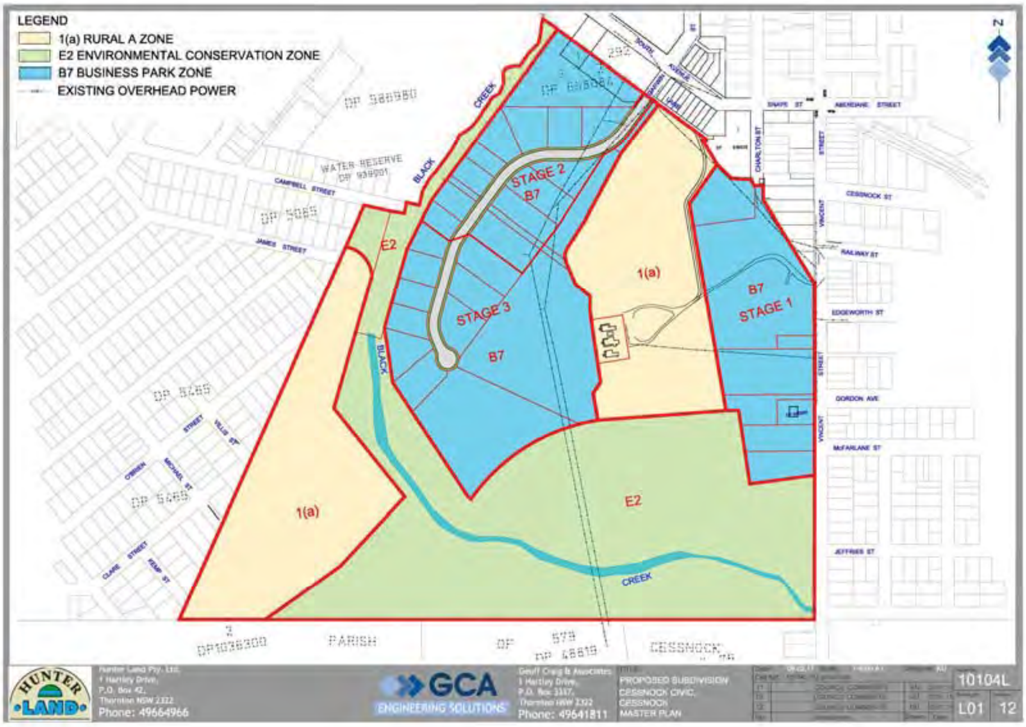

Figure 2 – Indicative subdivision Layout and Staging Plan

B Subdivision Pattern and Development Staging

Figure 2 shows an indicative plan of subdivision of the land. The land is divided into areas which may be developed separately as part of the staging of the development. The RU2 Rural Landscape zoned land located between the two areas of B7 zoned land may be deemed suitable for development subject to further geotechnical investigations. Accordingly, the final road layout should make provision for road access to that land.

C Subdivision of Land

Planning Principles

(a) To ensure that B7 Business Park, E2 Environmental Protection and RU2 Rural Landscape zoned land develop in an integrated manner.

(b) To ensure that land that is considered unsuitable for development due to mine subsidence is identified and a Management Plan ensures public safety.

(c) To ensure that subdivision is in accordance with the land capability of the site and that development minimises soil erosion and impact on natural systems.

(d) To ensure the native vegetation of the site is not adversely affected by the development.

(e) To ensure that vehicular linkages and roads are designed and constructed to a standard appropriate for the development proposed, and in accordance with Council's Engineering Requirements for Development.

(f) To ensure that adequate provision is made for pedestrian/cycle links.

(g) To ensure that adequate open space is provided in accordance with Council's requirements.

13.2.2 Detailed Development Considerations

A Flooding and Drainage

A comprehensive flooding drainage report (Cessnock Civic Flood Study for Rezoning GCA Engineering Solutions February 2011) is attached as **Annexure A.** The main recommendations of the report are reproduced in this chapter.

The site is located within the Black Creek catchment, upstream of the township of Cessnock, and is affected by flooding. The flood levels vary within the site.

The Flood Study explored a potential site earthworks (filling) solution to provide flood protection to the development areas. Through hydraulic modelling of the potential solution it was predicted that:

- The extent of suggested filling is highly unlikely to have an adverse impact on flood levels upstream of the proposed development site during the 1% AEP event (Patterson Britton 2010, confirmed by GCA 2011).

Principles

- The quality of water within downstream creeks, rivers and other natural and man-made water features should be maintained or improved.
- Development is to be in general accordance with the principles of the NSW Floodplain Development Manual (NSW Government Department of Infrastructure Planning and Natural Resources, 2005).
- Flooding of properties upstream or downstream of the site is not to be adversely affected by the development of the Cessnock Civic site.

DEVELOPMENT CONTROLS

Stormwater

- Development consent will not be granted for the subdivision of land unless a stormwater management plan has been prepared to the satisfaction of Council. The stormwater management plan shall include, but is not limited to, water quality treatment measures to protect the quality of downstream receiving waters. These measures may be provided at a subdivision level, allotment level, or a combination. The stormwater management strategy shall clearly outline the requirements for any allotment controls that will be required in any development application, including individual buildings.
- Stormwater detention structures may not be necessary at a subdivision or individual site level or building. If detention is not necessary, stormwater may be able to be discharged directly into Black Creek or associated drainage lines after passing through a water quality treatment device (or devices).
- The design of stormwater management systems is to be undertaken in accordance with Cessnock City Council's engineering requirements for development, unless otherwise varied by the content of this DCP.
- Design storms and flow rates shall be determined using the procedure in the current version of Australian Rainfall and Runoff.
- An underground piped drainage system is to be constructed within the road alignments to provide sufficient depth for lots to drain and shall be designed to convey the flow rate from the design 10 year Average Recurrence Interval (ARI) event.
- Additional piped drainage features (e.g. inter-allotment drainage lines) are permissible for areas other than roads within the development, where required and appropriate.
- The combination of the pipe drainage network and water within the road reserve is to convey the 100 year ARI event. The depth velocity product of surface water for the 100 year ARI event within the road reserve is to be less than $0.4m^2/s$ unless special safety features are provided.
- Cross drainage (culverts and bridges) shall be designed to convey the design critical 100 year ARI storm event. The design of subdivision earthworks levels shall consider the potential increase in flood water as a result of the cross drainage structures, including an appropriate allowance for blockage. Concessions may be granted for larger culvert diameters, open span bridges or where additional features (i.e. trash racks) are installed to reduce the likelihood and magnitude of blockage.

- Any drainage easements and reserves within the site shall be constructed and dedicated to Council (at no cost) at the subdivision stage or prior to occupation.
- Alternative methods and criteria for design of stormwater systems (for example, continuous simulation using rainfall data) may be proposed and considered on merit.

Flooding

- Finished ground levels within the Zone B7 Business Park are to be designed so that all lots less than 5000m^2 in area have at least 80% of the lot area at or above the design 1% AEP flood level. Lots greater than 5000m^2 in area are to have at least 50% of the lot area at, or above, the design 1% AEP flood level.
- All buildings shall have finished floor levels above the 1% AEP flood level, within the B7 Business Park zone
- There is no specified minimum surface level within asset protection zones, land to be dedicated to Council as drainage reserve, or other non-developable areas of the site.
- Earthworks levels are to be designed with consideration to evacuation and egress during an extreme flood event. All parts of the access route shall be of ‘all weather’ type construction (i.e. bitumen seal, segmental paving, or concrete).
- Development consent will not be granted for the subdivision of land unless a flood assessment report has been prepared to the satisfaction of Council that determined the measures prescribed in this DCP will be achieved by the development. In addition the Development Application flood assessment report should:
    - Clearly identify the finished floor level requirements for buildings on each lot, to assist Council with the assessment of development applications.
    - Demonstrate that the proposed extent of filling will not have an adverse impact on flooding within properties around the site up to and including the 1% AEP event.
    - Take into account earthworks for the entire site.

B Mine Subsidence Zone

Detailed technical reports have been completed by Parsons Brinckerhoff (PB) to address the mine subsidence issues on the site. These reports comprise:

- ➢ Zone A Mine Subsidence Investigation – Factual Report
- ➢ Zone A Mine Subsidence Investigation – Interpretive Report

These reports identify the areas of the site which are generally suitable for buildings, and the constraints to development which may apply to specific locations. Certain areas within the Zone B7 Business Park area either require specific building and foundation arrangements (e.g. piling) or are suitable for hardstand only. Development proponents should seek to confirm the suitability of a site or parts of a site for the development proposed.

Other areas of the site that have not been fully investigated, or have been identified as having significant subsidence concerns, were identified and are retained as zone RU2 Rural Landscape or zoned E2 Environmental Conservation under the LEP. The rural zoned land may have development potential when further investigated, but this must not occur if the Mine Subsidence Board raises an objection with development on that land.

Note: the Cessnock Civic site is not within a Mine Subsidence District.

Principles

- No development shall be undertaken contrary to the Parsons Brinkerhoff (PB) "Cessnock Civic Centre, Zone A Mine subsidence Investigation - Investigative Report (January 2010)".
- Long term monitoring and site management will be undertaken in accordance with the GCA Engineering Solutions "Cessnock Civic, Plan of Management for Mine subsidence (June 2011)".
- The overall site is managed to deal with the risks associated with mine subsidence for the areas with which the Mine Subsidence Board either objects or disagrees with development.
- Repair of any surface subsidence event must be undertaken to a standard which ensures public safety.

DEVELOPMENT CONTROLS

Mine Subsidence / Geotechnical Constraints

- Development on the site must be carried out in accordance with the conclusions of the PB "Cessnock Civic Centre, Zone A Mine Subsidence Investigation – Interpretive Report", and attention is particularly drawn to Figure 11 Revision C of the report and what building conditions will apply. Figure 11 is reprinted at **Figure 3** to this DCP.
- **Development applications must demonstrate that the proposed development is consistent with the PB Interpretive Report and that the potential for mine subsidence affecting the development is minimised to the satisfaction of the consent authority.**

In summary:-

- Area A (1) - buildings designed to span 5m potholes.
- Area A (2) - buildings shall be piled below the existing workings.
- Area A (3) - no building construction, parking and hardstand areas only.
- Area B - no development, as the area is yet to be investigated.
- Area C - no development, as the area is yet to be investigated.
- Area D - no development, as the area is yet to be investigated.
- Area E (1) - backfilled open cut, excavation and re-compaction or provision of an engineered bridging layer.
- Area E (2) - buildings shall be piled below the existing workings.
- Area E (3) - no development.
- Area F - not undermined, standard slab construction, it is noted the old drifts in this location shall be dug out prior to development occurring over them.
- Area G - not undermined, standard slab construction.
- Area H - no development as the area is yet to be investigated.

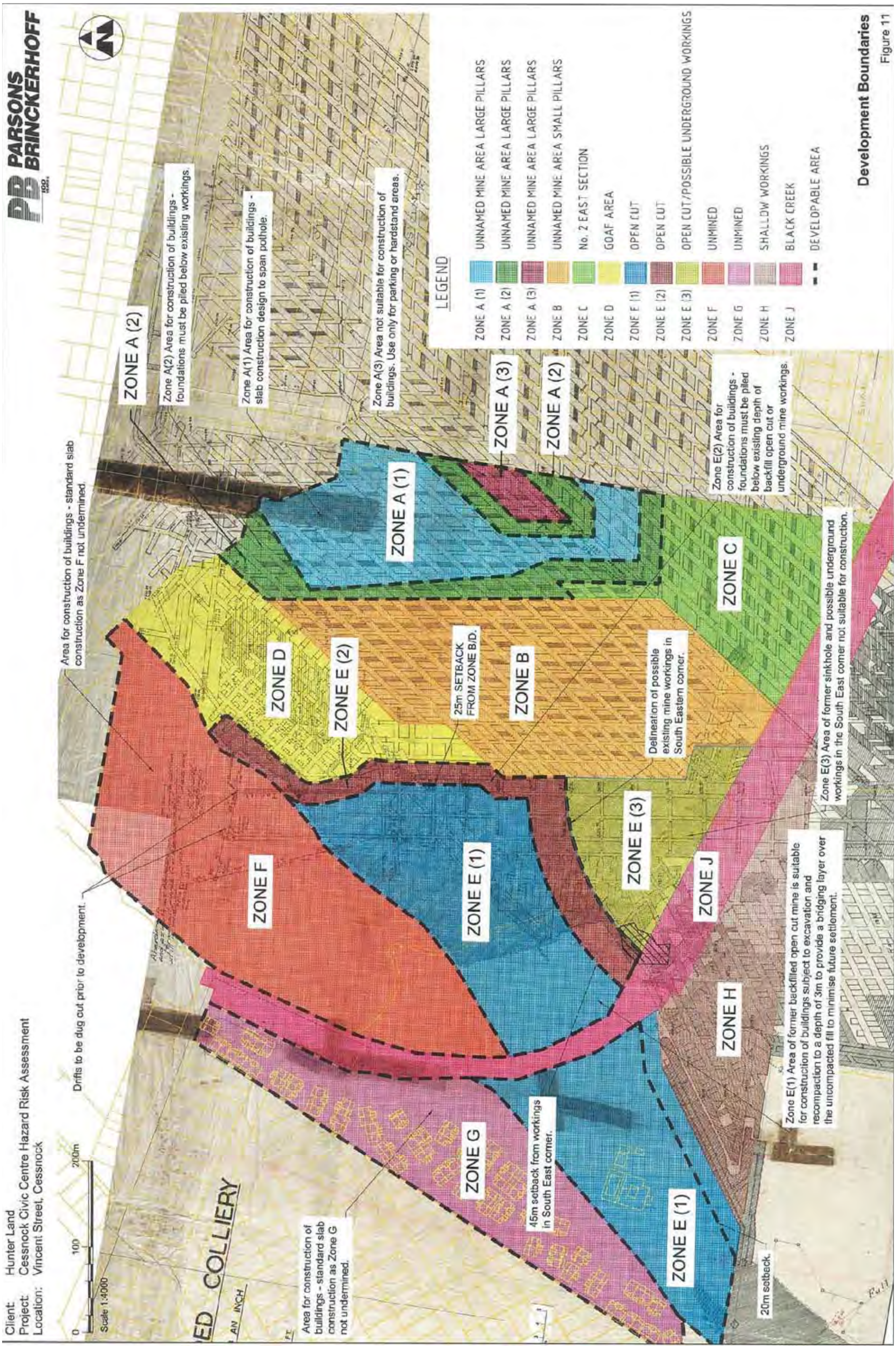

Figure 3 – PB Figure 11 Rev C Cessnock Civic Interpretive Report

The Mine Subsidence Board (MSB) did not object to development on the site subject to it being carried out strictly in accordance with the recommendations of the PB Report. The MSB Correspondence is attached as **Annexure B**.

For the purpose of development on the site, a simplified plan (Building Conditions in Residential and Commercial Project No. 10104L Drawing No. L06 Revision 11 attached as **Figure 4**) has been prepared which details the likely building construction requirements for parts of the site as follows:

- Land marked with small hatches on this plan show the area where buildings are suitable for construction following excavation and re-compaction to a depth of 3m to provide a bridging layer over uncompacted fill. A report is required to be submitted to Council stating that this has been achieved and is required prior to the issue of the subdivision certificate for this land.
- Building conditions apply to the land shown with large hatches. The conditions require that foundations must be piled below existing depth of backfilled open cut or underground mine workings.
- The land marked with crosses requires slab construction to span pothole.
- The land marked with diagonal solid and dashed lines requires foundations to be piled below existing workings.
- Only hardstand or parking areas are permitted on the area marked with small circles.

A Plan of Management for Mine Subsidence prepared by GCA Engineering Solutions (16 June 2011) contains a strategy to deal with risks associated with mine subsidence areas. The Plan of Management for Mine Subsidence is attached as **Annexure C**.

Consent shall not be granted for development on the land unless the consent authority is satisfied that the Plan of Management for Mine Subsidence will be implemented in perpetuity. The landowner has proposed a Voluntary Planning Agreement to achieve this objective.

The site is to be managed in accordance with the recommendations of this “Plan of Management for Mine Subsidence”. This includes, but is not limited to:

- ➢ Construction of a man proof fence to prevent public access.
- ➢ Restricting site access to three main locations at which point locked gates will be established.
- ➢ Providing routine surface inspections of the site and compliance with the detailed flow chart provided in the Plan of Management, should a subsidence event occur.

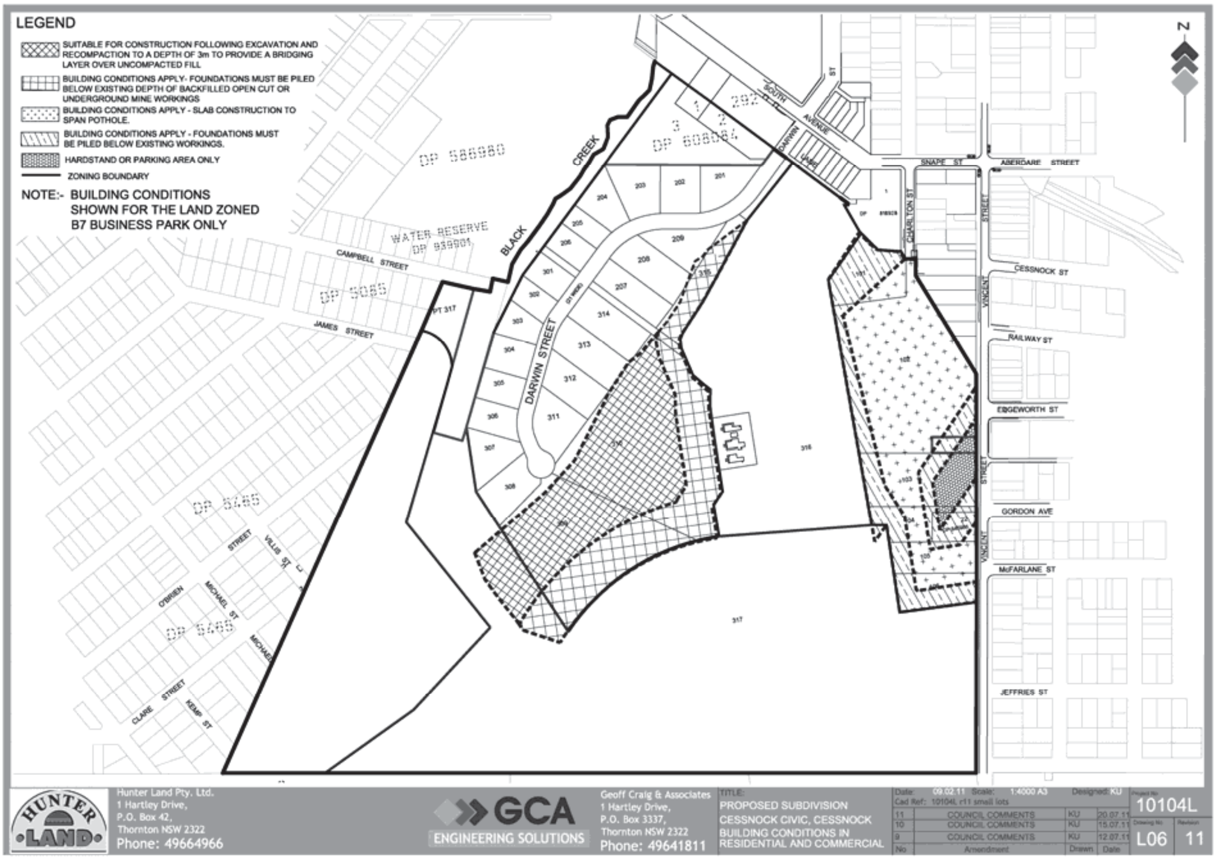

Figure 4 – Building Conditions Plan – GCA

C Traffic Management

A detailed Traffic Impact Assessment was undertaken by Insite Engineering Services Pty Ltd (February 2011). The proposed staging for the development is shown on **Figure 2**.

The main transport access routes to the site will be via Darwin Street and Wollombi Road or Aberdare Road, Snape Street and Vincent Street.

The following (but not limited to) should be provided in response to the anticipated demand generated by development on the site:

1. A roundabout or traffic signals be constructed at the Darwin Street / South Avenue / Snape Street intersection prior to construction of Stage 2 of the development; and
2. The upgrading of the traffic signals at Aberdare Road / Vincent Street to provide additional approach and departure lanes, to occur prior to construction of Stage 3 of the development.
3. Upgrading of Vincent Street along the frontage of the development, and the alignment of Vincent Street immediately north of the site, consistent with Council's Engineering Requirements for Development.
4. Provision of pedestrian and cycle links to the existing pedestrian and cycle networks in Vincent Street.

These external works will be required as part of the development consent requirements relating to the Business Park.

13.2.3 Specific Controls

A Traffic/Road Pattern, Cycleways and Linkages

Proposals for subdivision should be prepared having regard to the following design guidelines:

(a) The road pattern shall be developed generally in accordance with **Figure 4**, but the layout is indicative only and may be varied in the course of detailed subdivision planning.

(b) Provision should be made for possible road access to the central RU2 Rural Landscape zoned land because this land may be deemed suitable for development after further geotechnical investigation.

(c) Suitable legal access is to be provided to all land.

(d) All road and drainage works within the site are to be designed and constructed to a standard appropriate for the proposed development and in accordance with Council's Engineering Requirements for Development.

(e) Subdivision layouts shall take into account any cycleway and/or linkages plan adopted by Council.

(f) The traffic/road pattern shall take into consideration the Traffic Impact Assessment Prepared by Insite July 2010.

All costs associated with the construction of roads within the site are to be borne by the developer.

B Vegetation Management and Landscaping Plan

A Landscape Plan must be lodged for the approval of Council as part of the subdivision of each stage.

The Landscape Plan must enhance the visual amenity of Vincent Street by addressing public spaces and streets.

The Landscape Plan should maximise the planting of locally occurring native plant species.

Consent for the subdivision of the land should not occur until a Vegetation Management Plan for the E2 Environmental Conservation Zone has been lodged to the satisfaction of Council. The Vegetation Management Plan is to specify:

- All proposed areas of Kurri Sand Swamp Woodland (KSSW) to be retained and connections to proximate areas of similar habitat to be reasonably maintained on site.
- Controls to protect the KSSW, creek line and any other areas conserved are implemented, including fencing, sediment control devices and appropriate signage.
- Existing trees are to be retained where possible; consideration should be given to locating open space where it results in the retention of groups of existing trees.
- Existing mature and hollow habitat trees should be identified on a plan and should be retained wherever possible.

- Where a habitat tree needs to be removed, a clearing protocol for their removal is to be prepared and included in the Vegetation Management Plan.

C Fencing

The developer must provide man proof fencing as shown on the plan prepared by GCA and attached to the Plan of Management for Mine Subsidence prepared by GCA Engineering Solutions 2011 (**Annexure B**). This fence shall be installed in the manner detailed in the Plan of Management. The fencing is to have provision to the movement of native fauna across the fence line along the southern boundary of the subject land.

13.2.4 Area Specific Requirements

A Business Park Zone

INTRODUCTION

Application

This part of the DCP applies to all land to which this DCP applies that is zoned, or developed for Zone B7 Business Park purposes.

Vincent Street Precinct (Stage 1)

Site layout and building design will be carefully controlled via the implementation of appropriate building setbacks and the stipulation of building façade and landscaping treatments. This area is an extension of Vincent Street leading to sporting facilities and is an arterial road.

Central Precinct (Stage 2 and 3)

The Precinct will be developed in two (2) stages. The future internal road layout will provide access to all parts of the precinct via Darwin Street (from South Street).

Purpose

To provide more detailed guidelines than those contained in the Cessnock LEP 2011.

Aims and Objectives

The aims and objectives of the B7 Business Park Zone are to:

(a) To provide for a range of bulky goods, commercial and service business developments that support the higher order function of the adjacent Cessnock CBD.

(b) To achieve high quality integrated development which has regard to the visual prominence of the land through the use of appropriate architectural elements, quality materials and finishes.

(c) To establish appropriate pedestrian and vehicular access to and within the site.

(d) To provide guidelines which detail the methods in which flooding and drainage issues are to be appropriately managed.

(e) To protect the amenity of the adjacent residential properties through building setbacks, building design and landscaping.

GUIDELINES FOR DEVELOPMENT

Landscaping

Principles

To improve the visual quality and amenity of business park development through implementing effective low maintenance landscaping.

To protect the amenity of residents and premises located on Vincent Street.

Controls

Those areas of the site to be landscaped include:

a) The landscaped front setback area to be a minimum depth of:
   i) Three (3) metres on the internal subdivision roads.
   ii) Six (6) metres for lots on Vincent Street.
b) The side and rear setbacks if visible from a public place;
c) Large vehicular parking areas should be landscaped to provide shade and soften the visual impact of parking facilities.
d) Landscaping of the front boundary should be of a high level with dense landscaping provided within the front setback area.
e) Landscape design and plant selection should ensure low maintenance requirements and low water demand.

Building Design

Principles

To provide buildings which are both functional and attractive in the context of their local environment.

Controls

Offices, showrooms and customer services areas:

- Are located towards the front of the development.
- Are of a higher architectural standard
- Present an attractive façade to the street.

Business Park Buildings fronting Vincent Street

Principles

Streetscape appearance and the management of potential interface amenity issues with adjoining residential properties is a high priority for the proposed commercial buildings fronting Vincent Street.

Controls

For buildings fronting Vincent Street, the following requirements apply:

- Buildings located at the front of the development should have a high architectural design standard.
- All buildings (other than the roof) are to be constructed of non reflective materials.
- All noise emitting services, such as air conditioning equipment, pumps and ventilation fans should not be located at the front of the building.
- Waste bins shall not be located at the front of the building.
- Security fencing (if required) shall be erected along the building line rather than along the street frontage and screened by landscaping.
- Front property line fencing shall have no solid walls higher than 1.2 metres.
- Lighting shall be on site only and shall not cause glare or excessive light spillage on neighbouring sites.
- Access points to Vincent Street are to be minimised and located so as to minimise adverse impacts on residences.

Building Setbacks

Existing residence – 261 Vincent Street Cessnock

- A minimum building setback of 10 metres will be provided to the side boundaries of the existing residence at No. 261 Vincent Street Cessnock.
- This setback will be extensively landscaped and no structures or noise emitting sources shall be permitted within the setback.

Outside Storage and Work Areas

a) External storage and work areas are to be located behind the building and screened from public view by means of fencing.

b) Product display may be located in front of the building.

Security Fencing

Security fencing should be preferably located within or behind the front landscaped area.

Drainage

Principles

1. To ensure adequate drainage facilities are provided within the site to collect and carry stormwater to external drainage systems.
2. To prevent the hazard of flooding and diversion or concentration of water onto adjoining properties or public areas.
3. To ensure that the public drainage systems can adequately accept additional runoff generated by developments.

Controls

a) Stormwater run-off from roofs and paved areas is to be collected on site and disposed of to the street drainage system, drainage easement, natural drainage course or infiltration trench, or other means as determined by Council (see Council's Engineering Requirements for Development).

b) Earthworks levels within the B7 Business Park are to be designed so that all lots less than 5000m^2 in area have at least 80% of the lot area at or above the design 1% AEP flood level. Lots greater than 5000m^2 in area are to have at least 50% of the lot area at or above the design 1% AEP flood level.

c) Construction of buildings on each lot within the B7 Business Park zone shall be undertaken so that all buildings have finished floor levels above the 1% AEP flood level.

Lighting Design

Lighting shall be on site only and shall not cause glare or excessive light spillage on neighbouring sites.

Signage

All signage within the Business Park Zone shall comply with Council's requirements. Signage shall be complementary in scale and form with the built environment and the streetscape as a whole.

Signs shall not be illuminated or flashing.

B Rural Zone

GUIDELINES FOR DEVELOPMENT

INTRODUCTION

Application

This part of the DCP applies to all land to which this DCP applies that is zoned RU2 Rural Landscape.

Subject to further geotechnical investigation, opportunities may exist for some adjoining uses to expand into limited areas of this precinct in the future. The existing vegetation in this precinct is akin to landscaped parkland and future businesses within the surrounding precinct may see the residual lands as offering an attractive setting.

The existing miners' cottages are located within the precinct and adaptive re-use of these buildings is encouraged in accordance with Clause 5.10 (10) of the Cessnock Local Environmental Plan 2011. The woodland vegetation will act as a semi natural backdrop for the miners' cottages.

Purpose

To ensure sound development of the rural zoned areas of the Precinct.

Controls

- The RU2 Rural Landscape zone applies to the central part of the site which may have potential for future addition to the Business Park. For this to occur, extensive geotechnical testing equivalent to that undertaken is required.
- The role of the existing vegetation should be assessed as part of any development application.

C Environmental Conservation Zone

This part of the DCP applies to all land to which this DCP applies that is zoned Zone E2 Environmental Conservation.

The zoning plan provides opportunities for landscaping, the rehabilitation of vegetation and the provision of buffers along a rehabilitated Black Creek. Landscaped buffers will be managed to improve the amenity of the site and improve the environmental outcomes. Significant habitat and established trees will be maintained across the site wherever possible. Access is likely to be restricted to this area for safety and security of adjoining uses.

Purpose

To manage and protect the proposed conservation area in perpetuity.

Controls

The ongoing management of the conservation area should be guided by a Vegetation Management Plan (VMP). The VMP shall be submitted in conjunction with any development application for the development of the site.

The VMP shall include details of revegetation, restoration and weed control effort including the riparian corridors. Areas affected by degradation, erosion and/or rubbish dumping should also be rehabilitated subject to any conditions imposed by the consent authority.

Fencing shall be installed surrounding the conservation area to prevent public access, rubbish dumping and use by recreational vehicles.

All asset protection zones and stormwater retention basins are to be located outside the E2 Environmental Conservation Area.

Fencing along the southern boundary of the site will make provision for native fauna movement across the site boundary

13.2.5 Possible Future Development

Land zoned RU2 Rural Landscape cannot be rezoned at this time primarily because the geological conditions in this zone have not been fully investigated. However, subject to further geotechnical investigation, future opportunities may exist for adjacent zones to be extended into limited areas of this land.

Land on the western boundary of the site has been identified as having residential potential but is unable to be rezoned and developed due to rehabilitation activities of Austar Coal located to the south. These activities relate primarily to the Aberdare Emplacement Area (AEA) which is located only a short distance from the Cessnock Civic Precinct. The AEA is a former open cut mine void used for the emplacement of washery reject material and subsequent progressive rehabilitation is underway in accordance with relevant approvals issued over the land. A major reason why the rezoning of this land has not occurred at this time due to the potential incompatibility of the rehabilitation works and residential development within the Cessnock Civic Precinct.

The Mine Operations Plan provides for the progressive rehabilitation of the adjoining land (which is now underway) in a westerly direction away from the Cessnock Civic Precinct.

In summary two areas may be considered for rezoning in the future:

1. Certain land zoned RU2 Rural Landscape to Zone B7 Business Park land, after the geological conditions have been investigated and no objection is received from the Mine Subsidence Board.
2. Certain land on the western boundary of the site zoned RU2 Rural Landscape to a residential zone, when it can be demonstrated that the rehabilitation works to the south have progressed to a point where potential issues of incompatibility are no longer a consideration

Annexure A

GCA Flooding and Drainage Report 21 September 2011

Cessnock Civic

Flood Study for Rezoning

Vincent Street Holdings Pty Ltd

FINAL

Revision: C
Version Date: 21 September 2011

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10104 \ Cessnock Civic Rezoning Flood Study (Rev C)

Revision	Description	Author		Review		Approved	
0	Original – Draft Issue	AS		IH		IH	
A	Final Issue	AS	16.07.10	IH	16.07.10	IH	16.07.10
B	Revision for regional planning panel	AS	14.02.11	IH	14.02.11	IH	14.02.11
C	Revised to reflect updated zone plan	AS	21.09.11	IH	21.09.11	IH	21.09.11

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Glossary

Selected key flood-related terminology is provided below, based on the NSW Floodplain Management Manual (NSW Government, 2005).

Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (or one-in-twenty) of a 500 m^3/s or larger event occurring in any one year.
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge greater than or equal to the 20 year ARI flood event will occur on average once every 20 years.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding a tsunami.
floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event. Also known as 'flood liable land' or 'flood prone land'.
flood storage area	Those parts of the floodplain which are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
flood hazard	A source of potential harm or a situation with a potential to cause loss. In relation to the Floodplain Development Manual the hazard is flooding which has the potential to cause damage to the community. The allocation of provisional low and high hydraulic hazard in flood mapping is generally a function of flood flow velocity and depth. The actual hazard considers other factors that may also influence the likelihood and extent of loss of life and/or damage such as warning time, local emergency response, the type of development, and ease of egress for evacuation.
Probable Maximum Flood (PMF)	The largest flood that could conceivable occur at a particular location, usually estimated from the Probable Maximum Precipitation. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone (or flood liable) land.
Probable Maximum Precipitation (PMP)	The greatest depth of precipitation for a given duration meteorologically possible over a given size of storm area at a particular time of year, with no allowance made for long term climatic trends. It is the primary input to the estimation of the Probable Maximum Flood.

List of acronyms

ARI	Annual Recurrence Interval
AEP	Annual Exceedance Probability
CCC	Cessnock City Council
DCP	Development Control Plan
DHI	DHI Water and Environmental
DECCW	NSW Department of Environment, Climate Change and Water
GCA	Geoff Craig and Associates Pty Ltd, also GCA Engineering Solutions
LEP	Local Environment Plan
NOW	NSW Office of Water
PMF	Probable Maximum Flood

1. Introduction

1.1 Background and objectives

Vincent Street Holdings Pty Ltd is seeking an amendment to the Cessnock Local Environment Plan (LEP) for rezoning of Lot 23 DP845896 and Lot 1 DP1036300 into a mixture of business park, rural and environmental land uses.

Black Creek traverses the site and previous investigations (by GCA and others) have determined that portions of the site are affected by flooding in the 1% Annual Exceedance Probability (AEP) flood event and the Probable Maximum Flood (PMF).

GCA Engineering Solutions (GCA) was engaged by Vincent Street Holdings Pty Ltd to provide a flooding assessment for rezoning. This report:

- Provides information on the existing flood environment.
- Assesses the flood impacts of a potential engineering (earthworks) solution to demonstrate that surrounding properties will not be adversely impacted.
- Documents flood risk management considerations for the proposed development.

1.2 Structure of this report

This report is structured in 5 sections as follows:

Section 1	Introduction, which provides information on the study background, study objective, the proposed development, and a description of the drainage catchment.
Section 2	Methodology for this flood study.
Section 3	Existing flood conditions, including results from flood modelling.
Section 4	Developed flood conditions, including a description of the identified engineering (earthworks) solution and the results from flood modelling.
Section 5	Conclusions and recommendations.

1.3 Proposed development

The location of the proposed development is shown on Figure 1.

Figure 1 Locality plan
(Image obtained from Google Maps)

The site is situated between Vincent Street (east), existing industrial lots and a retirement village (north), existing residential development (west) and open space reserve (south), as indicated on Figure 2 (over page).

The proposal involves rezoning the site into a mixture of land uses including business park, environment and rural. The proposed land use zones are shown on Figure 3. The proposed zones have been prepared (by others) primarily with consideration to the site's geotechnical site constraints that are largely due to historical coal mining activities.

It is proposed to retain the 1(A) Rural zoning over the portion of the site immediately east of existing residential development (on the south-west side of Black Creek). However, this portion of the site has been identified as having potential for residential land use in future. This land with potential for residential land use has been included in the flood modelling for this study to ensure that combined impacts of development on both sides of Black Creek are taken into account. The rezoning of this portion of the site for residential land use is subject to a future rezoning application to Council, and does not form part of the immediate rezoning application submitted by the Proponent to Cessnock City Council.

Geotechnical reports by Parsons Brinckerhoff (PB) and others have indicated that the western half of the site (including a large proportion of the business park area) has been previously mined using open cut methods. There is anecdotal evidence to suggest that Black

Creek within the site, which was formed as part of the rehabilitated landform, is not on the same alignment and does not have the same cross section prior to the open cut mining activities.

1.4 Drainage catchment and site features

The site is situated within the Black Creek catchment, which is bounded by the Broken Back Range (south and west) and the Wallis / Swamp Creek catchment to the east. Black Creek runs through the township of Cessnock, where it collects water from Limestone Creek and Bellbird Creek, before flowing further north to the township of Branxton and into the Hunter River. The total Black Creek catchment area is approximately 27,000ha.

The approximate Black Creek drainage catchment area to the northern boundary of Lot 1 DP 1036300 (at West Avenue) is 2,940ha.

The main channel of Black Creek is open and naturally lined within the site, upstream of the site, and downstream of the township of Cessnock. Within Cessnock (from West Avenue onwards) the channel is concrete-lined. There is an open water body situated on Black Creek adjacent to an existing retirement village at the northern site boundary.

Three local drainage lines intersect with Black Creek on the parent site;

- The primary additional drainage line (Drainage Line 1) is located in the south west of the site and bisects the land with residential potential. This channel was possibly constructed to divert runoff around previous mine operations, and receives surface water from the existing residential areas to the north west. From discussions with Austar mine it is understood that the upstream mining area is in the process of being rehabilitated, which will result in diversion of a significant area of additional upstream catchment into this drainage line. Flood modelling for this study assumes full rehabilitation of the mine site, accounting for the full future flow through Drainage Line 1.
- A second local drainage line is located in the south-east of the site and drains runoff from the racecourse. In the south-east corner this drainage line essentially combines with Black Creek to form a low lying area that would pond water and flood frequently even during less intense rainfall events.
- A third minor drainage line collects runoff only from local area within Lot 1 DP1036300, and is located between drainage lines 1 and 2. This flood study and studies by others have determined that regional flood flow will split out of Drainage Line 1 into this minor drainage line during extreme events.

All three minor drainage lines are generally degraded, with little apparent native vegetation.


Client: Vincent Street Holdings Pty Ltd
Project: Cessnock Civic - Flood Study for Rezoning
Location: Cessnock, NSW
PROJECT NUMBER: 10104 dFO2rC
DATE: 22.09.11
50 0 50 100 150 200 250m
SCALE 1:5000 (A3)
GCA
ENGINEERING SOLUTIONS
N
WATER RESERVE
DARWIN ST
SNAPE
CHARLTON STREET
STREET
CAMPBELL ST
JAMES ST
BLACK CREEK
CESSNOCK ST
RAILWAY ST
VINCENT ST
EDGEWORTH ST
O'BRIEN ST
VILLIS ST
MICHAEL ST
GORDON AVE
CLARE ST
McFARLANE ST
BLACK CREEK
JEFFRIES ST
Site Context
FIGURE 2

Proposed Land Use Zones

FIGURE 3

1.5 Previous flood studies

The following studies were considered in the preparation of this flood study for the rezoning of the Cessnock Civic site. They are listed and discussed in chronological order.

Cessnock Civic, Cessnock, Flood Study for Rezoning, Parsons Brinckerhoff, 2004

In 2004 Parsons Brinckerhoff (PB) completed a flood study and stormwater management strategy for the rezoning of the site to include both residential and commercial land uses. Catchment hydrologic modelling was completed using the RAFTS computer model and flood levels throughout the site were estimated using HEC-RAS. At the time a "sea wall" was proposed along Black Creek to protect the proposed residential and commercial / business park areas from flooding up to and including the 1% AEP event.

Additional geotechnical investigations were undertaken on the site following completion of the 2004 PB flood study, resulting in a reconfiguration of the land use zones. This triggered updated flood studies by PB and GCA, described later in this section.

The 2004 PB report also included a conceptual stormwater management plan for the commercial and residential zones proposed at the time. PB also completed hydrologic modelling and concluded that on-site stormwater detention was not required. This conclusion was supported by Council's drainage engineer. On this basis stormwater management has not been studied or considered any further for the rezoning phase of the proposed development site.

Black Creek Flood Study (Final Report), DHI Water and Environment, June 2010

DHI Water and Environment prepared the Black Creek Flood Study for Cessnock City Council (CCC) and the NSW Department of Environment and Climate Change (NSW DECC, now known as DECCW: NSW Department of Environment, Climate Change and Water). The Final Report (June 2010) has been adopted by Council for input to the future preparation of the regional Flood Risk Management Plan.

The DHI study used the MIKE-FLOOD (1D/2D coupled) hydraulic model to evaluate flood levels, velocities and hazard through the township of Cessnock. The Cessnock Civic site is situated on the southern boundary of DHI's MIKE-FLOOD model.

Complete flood mapping data from the DHI study was purchased from Council in GIS format for use in this flood assessment for Cessnock Civic rezoning. DHI's estimated flood level at Campbell Street was used as the downstream fixed water level boundary condition for this study. This methodology accounts for downstream controls that may force backwater upstream through the proposed development site. DHI's flood model results for Black Creek within the site were also used as a general comparison of existing scenario model results for this rezoning flood study.

Cessnock Civic, Cessnock, Flood Study for Rezoning, Parsons Brinckerhoff, June 2010

Further to the PB 2004 report and additional changes to the proposed land use zoning, PB completed a revised flood study that estimated the existing flood environment, prepared a concept (rezoning) engineering earthworks solution to facilitate development, and assessed the potential flood impacts of a potential earthworks solution on surrounding properties. PB's report included filling within both residential and business park portions of the site, providing building pads that would facilitate finished floor levels at least 0.5m above the post-development 1% AEP flood level.

The PB study proposed augmentation of Black Creek through Lot 1 DP1036300 to improve conveyance of flood flow.

Cessnock Civic, Cessnock, Flood Study for Rezoning, GCA, July 2010 to September 2011

GCA expanded on the PB rezoning flood study (June 2010) to provide flooding assessment for an alternative filling strategy for the proposed business park zone immediately north-east of and adjacent to Black Creek. This alternative strategy was assessed with consideration to NSW DECCW preference that works are not undertaken within Black Creek, preserving existing riparian vegetation where practical.

The alternative strategy proposed construction of a retaining wall along the business park zone boundary with Black Creek, avoiding any works within the defined creek channel. GCA noted that the approaches reported by both GCA and PB may achieve the objectives of the rezoning study; namely that filling of the site could be achieved without adversely impacting surrounding properties.

A concept development layout was not available for development within the portion of the land proposed (at the time) for residential zoning. The likely extent of filling in this area, for the purposes of the July 2010 GCA report (Revision A) was assumed using a nominal development footprint, with detailed assessment proposed to be deferred to Subdivision Development Application when the actual development proposal would be known.

Council and the Regional Planning Panel later requested that the July 2010 GCA flood study (Revision A) be expanded to assess the 'actual proposed landform'. This required a layout to be developed for the area proposed (at the time) for residential zoning, resulting in an updated Cessnock Civic Master plan (dated 9 February 2011). An updated flood study (Revision B, July 2011) was then produced using the updated Master plan.

Since July 2011 the proponent has withdrawn the proposal to rezone the land within the south-west corner of the site to residential land use. This report (Revision C, September 2011) comprises an update of the Revision B (July 2011) report to more appropriately describe the current rezoning proposal. The area previously proposed for residential is now referred to as *land with residential potential*. The estimated extent of future filling within the area of land with residential potential has still been retained for flood modelling purposes, so as to account for the potential combined impacts of filling on both sides of Black Creek. However it is reiterated that the current rezoning proposal will retain this portion of the site for Rural 1(A) land use.

1.6 Information sources

The following information was used for this study:

- Survey of the site provided by Harper Somers O'Sullivan.
- Subdivision layout and proposed land use zoning prepared by GCA in conjunction with Vincent Street Holdings Pty Ltd.
- Black Creek Flood Study (Final Exhibition Report, Nov 2009), prepared by DHI Water and Environment.
- Cessnock Civic Flood Study for Rezoning, June 2010, prepared by Parsons Brinckerhoff.

2. Methodology

Provided below is a brief description of the study methodology.

2.1 Hydrology

Previous studies by DHI, PB, Hunter Water Australia, and Stanwill Consulting Engineers had involved preparation of RAFTS catchment models to estimate existing flow rates in Black Creek and the local drainage lines for a range of design rainfall events.

Information from the Austar mine indicates that the future rehabilitated mine landform will direct the majority of the south-western catchment (478 ha) through the site, bisecting the proposed residential zone. To represent the distribution of catchment flow within the more detailed local site flood modelling, GCA constructed a Black Creek catchment hydrologic model in DRAINS software. The RAFTS hydrologic module was implemented in the DRAINS software so that the previous model parameters adopted by PB, DHI and others could be used directly.

Information on the DRAINS hydrologic model including a catchment plan and model subcatchment data is provided in Appendix A.

2.2 Hydraulics

1% AEP and PMF Flood levels from Black Creek and local drainage lines within the site were determined using the HEC-RAS hydraulic model. The HEC-RAS model used the peak 1% AEP and PMF flow rates determined from the DRAINS hydrologic model of the upstream Black Creek catchment.

The hydraulic model examined existing and future developed site conditions using the two landform models outlined in Section 2.3.

The existing 1% AEP and PMF flood levels from the HEC-RAS model were compared against levels from the DHI Black Creek Flood Study (obtained from Council).

The flood model results for the developed and existing scenarios were compared for the 1% AEP event to demonstrate that the potential earthworks solution would not increase flood levels to the extent that nearby and upstream properties would be significantly impacted.

The flood model results for the developed scenario Probable Maximum Flood (PMF) were also mapped so that flood risk management matters could be considered, as required by the NSW Floodplain Development Manual.

2.3 Landform models

The existing creek geometry and cross sections were determined using a digital terrain model (DTM) developed from detail survey current in 2007. The creek geometry near the south of the site underwent minor alterations following a mine subsidence event in June 2007. However, the remediated landform is not significantly different (in terms of flow hydraulics) to the pre-June 2007 conditions, and it is not considered necessary to develop a new 'existing' DTM for the site for the purpose of this rezoning flood study.

The existing and proposed landform plans are provided in Appendix B.

2.3.1 Proposed landform and flood planning levels

The concept landform model was prepared with consideration to the following proposed flood planning levels in the business park zone and land with residential potential:

- Business Park – Earthworks levels within the Business Park zone will be designed so that all lots less than 5000m^2 in area have at least 80% of the lot area at or above the design 1% AEP flood level. Lots greater than 5000m^2 in area are to have at least 50% of the lot area at or above the design 1% AEP flood level. Construction of buildings on each lot within the 3(e) / B7 Business Park zone shall be undertaken so that all buildings have finished floor levels at or above the 1% AEP flood level. The concept landform in this study however assumes that as much of the lot area as possible is at the 1% AEP flood level, in order to assess the upper limit of probable filling on this event.
- Land with residential potential – The 1% AEP event is generally accepted as the basis for setting flood planning levels for residential zones in NSW, as affirmed by the NSW Department of Planning circular PS-07-003 *New guideline and changes to section 117 direction and EP&A Regulation on flood prone land* (31 January 2007). The landform adopted for this study assumes that this area will be filled, as a minimum, to the 1% AEP flood level, as part of any future residential land use zoning proposal. Note this is subject to confirmation as part of a future updated flood assessment report that would accompany the future rezoning proposal. The local drainage line bisecting this area would remain, so as to ensure drainage of the upstream catchment areas.

Note that further details of the proposed landform will be provided at Subdivision Development Application (DA). Additionally, it is understood that a Development Control Plan (DCP) is currently being prepared for the Cessnock Civic precinct. The DCP currently proposes that an updated flood study report is prepared at subdivision DA to assess the updated site landform including any proposed auxiliary local drainage works.

3. Existing flood conditions

This section describes the results from flood modelling for the existing (undeveloped) scenario.

3.1 Hydrology

PB previously prepared a RAFTS model for the Black Creek catchment to determine the 1% AEP flow rates within the site, as documented in the 2004 and 2010 flood studies. The PB RAFTS model was based on Hunter Water Australia's (HWA) calibrated RAFTS model for the Black Creek catchment. Key flow rates are reproduced from the PB report in Table 1.

Table 1 Summary of 1% AEP flow rates from the 2004 and 2010 PB flood studies

Location	1% AEP flow (m^3/s)
Black Creek at upstream end of site at Vincent Street	57.7
Depression to southeast of existing residential development (Drainage Line 1)	2.6
Unnamed tributary draining racecourse (Drainage Line 3)	3.0
Unnamed tributary draining around previous mine operations (Drainage Line 2)	17.5
Black Creek at intersection of West, South and North Avenues (downstream of site)	82.3

PB's RAFTS model assumed that flow from the future rehabilitated Austar mine landform would flow through Drainage Line 3. The PB 2004 and 2010 studies did not evaluate PMF flow rates for the Black Creek catchment.

A DRAINS hydrologic model for the Black Creek catchment was prepared as part of this rezoning flood study. The purpose was to account for future hydrology due to the ultimate Austar mine rehabilitation plan, as well as obtaining the PMF flow rates. The RAFTS hydrologic module was implemented in the DRAINS software so that most of PB's RAFTS model parameters could be used directly. A summary of the resulting DRAINS model flow rates is provided in Table 2.

Table 2 1% and PMF flow rates as adopted for key locations within the site

Location	1% AEP flow (m^3/s)	PMF flow (m^3/s)
Black Creek at Vincent Street (Upstream end of HEC-RAS Hydraulic Model)	62.3	471
Drainage Line 1 (Upstream end collecting flow from future rehabilitated Austar mine landform)	24.1	145

The DRAINS model estimated flow rate of 62.3m^3/s for Black Creek at Vincent Street during the 1% AEP event is considered close to PB's estimate of 57.7m^3/s, given the general accuracy limitations for estimation of design flow rats over large regional catchments.

Note that drainage lines 2 and 3 are considered to be local drainage lines with flow rates at least an order of magnitude less than Drainage Line 1 and Black Creek. The flows in these lines are taken into account internally within the local site flood model.

3.2 Hydraulics

The HEC-RAS (Version 4.1, January 2010) computer model, developed by the Hydrologic Engineering Centre, U.S. Army Corps of Engineers was used to estimate the 1% AEP and PMF levels within Lot 1 DP1036300.

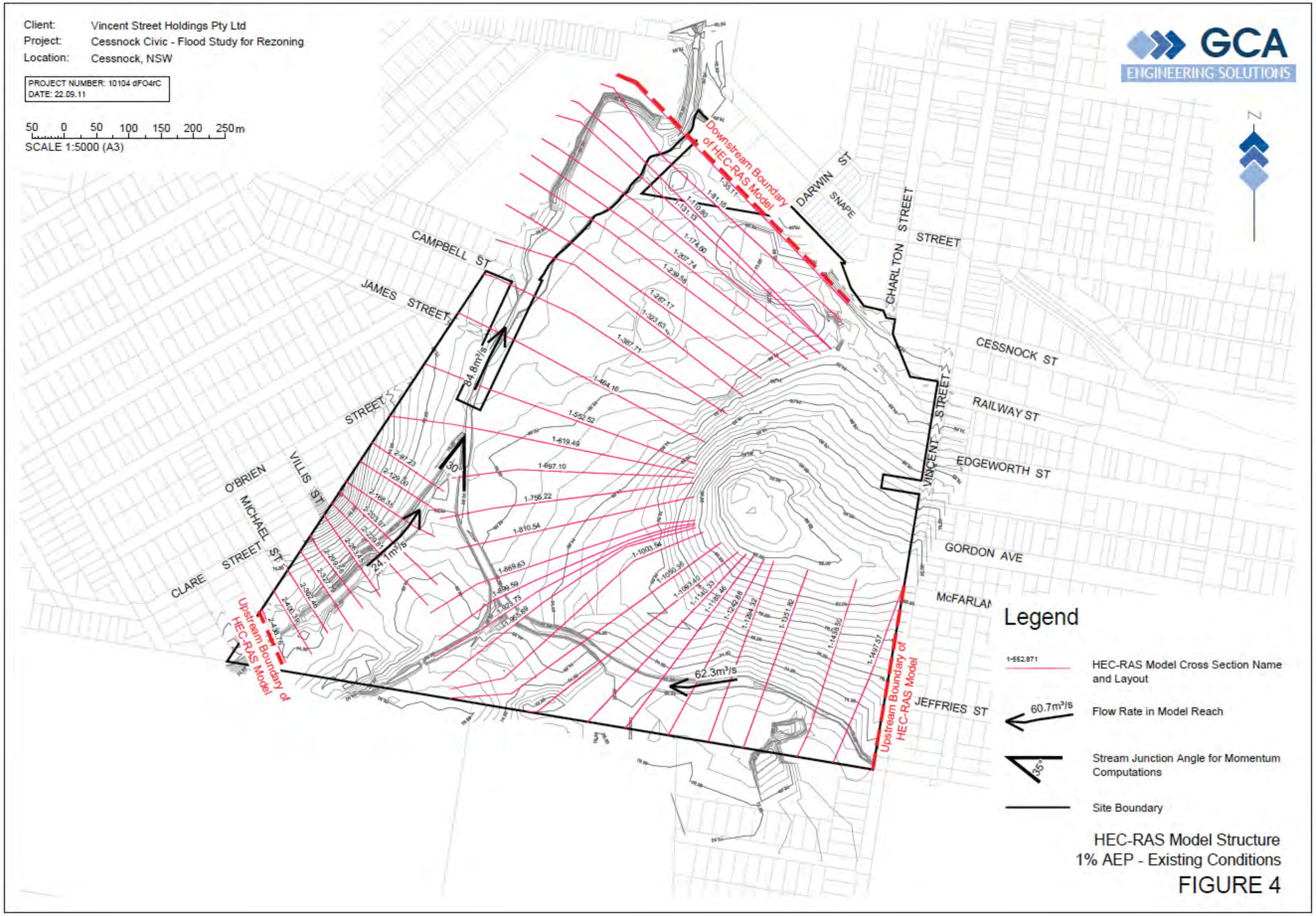
The model solves the one-dimensional energy equation to determine the water surface profile for either steady or unsteady state conditions. This study considers steady state conditions only, as this is generally a more stable computational mode and often provides more conservative flood level results than the unsteady computation method.

The flow behaviour is expected to be different in the south-west corner of the site for the 1% AEP and PMF flood events, and for the post-development scenario where the local drainage line will be augmented. This required production of four versions of the site HEC-RAS flood model.

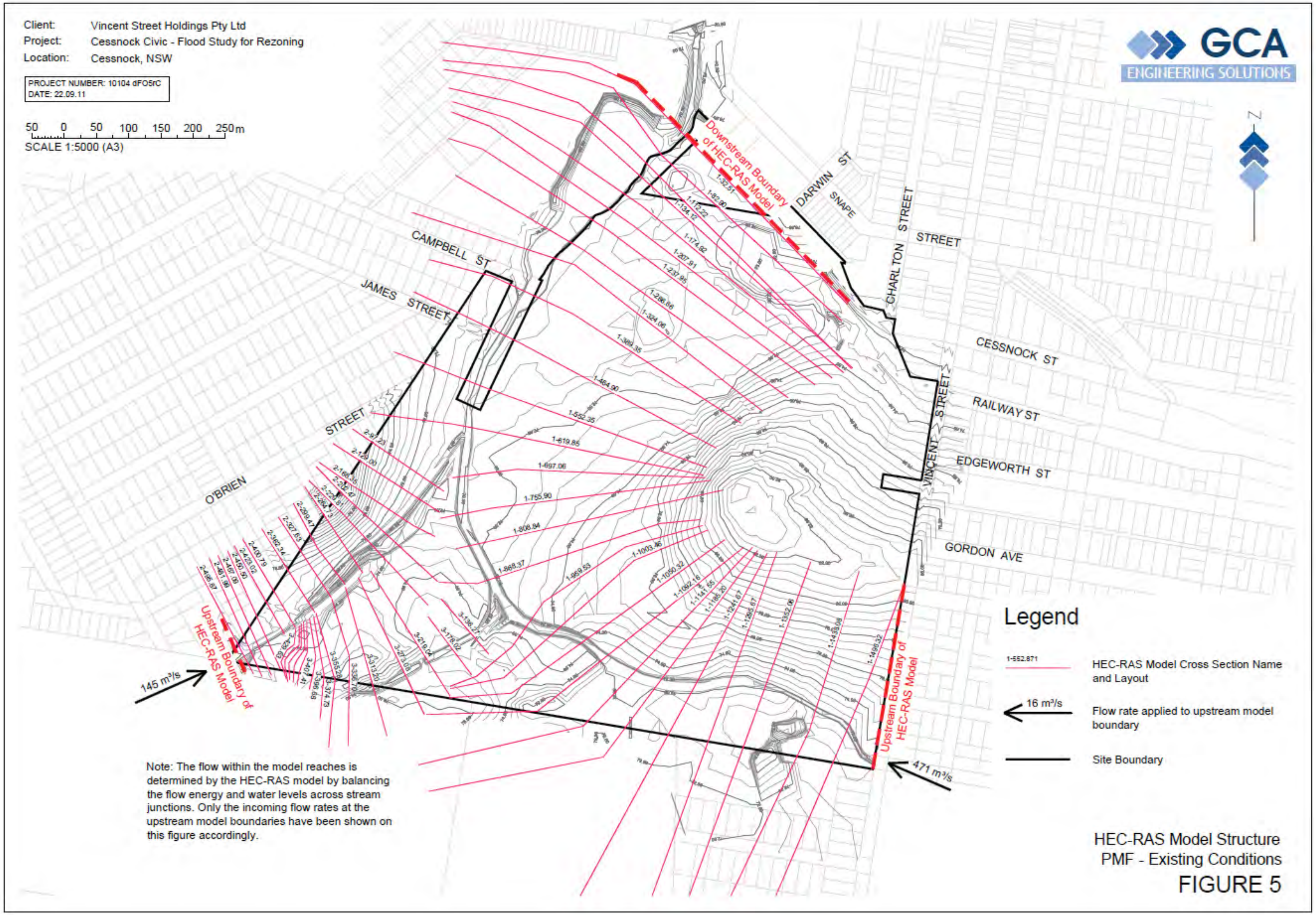
3.2.1 HEC-RAS Model Parameters

The following model parameters were adopted for the existing scenario HEC-RAS model (also refer to Figures 4 and 5):

- Model geometry consists of cross sections and the distance between them for the main channel and overbank regions. The model cross section layout and natural surface DTM is shown on Figure 4 for the 1% AEP event and Figure 5 for the PMF.
- The flow regime calculations can be specified as subcritical, supercritical or mixed flow. For this site a subcritical analysis was undertaken due to the very flat bed slopes (less than 0.5% within Black Creek) and the adoption of a relatively high fixed downstream was surface boundary condition. This assumption was later confirmed through interrogation of the model results.
- The downstream fixed water surface boundary condition was set at RL71.45 (1% AEP) and RL73m (PMF), using the flood levels in the DHI Black Creek Flood Study mapping provided by Council. This approach is considered appropriate given that the modelling for this study only considers a local portion of Black Creek and downstream hydraulic controls that force an elevated backwater profile through the site were accounted for in the DHI study.
- Model flow rates for 1% AEP event and the PMF were as estimated through the DRAINS hydrologic modelling process, as described in Section 3.1. Again it is noted that the flow rates assume that the upstream mine has been rehabilitated, which will result in substantially higher flow rates over those that would have generally occurred during operation of the mine.
- Manning 'n' values were set to 0.05 for the main channel and 0.08 for overbank areas. Developed areas within the overbank were set to 0.1 for the PMF model.
- Contraction and expansion coefficients (used in creek transitions) were set to 0.1 and 0.3 respectively, which are the default values for the HEC-RAS model. The full momentum equation was used at creek junctions using stream junction angles as measured from the plan stream layout.
- No hydraulic controls were included in the model for the site for the existing scenario.



HEC-RAS Model Structure
1% AEP - Existing Conditions
FIGURE 4



HEC-RAS Model Structure
PMF - Existing Conditions
FIGURE 5

3.3 Existing flood levels

Figures 6 and 7 are provided over page and show the existing 1% AEP and PMF flood envelopes within the site.

Further information on existing flooding within each zone is provided below. A comparison between the flood levels predicted in this study and the flood levels predicted in the DHI Flood Study (as adopted by Council) is also provided in Section 3.3.4 to validate the existing scenario HEC-RAS model results.

3.3.1 Business Park – eastern zone fronting Vincent Street

This area was not modelled in this flood study for rezoning, but is affected by flooding from the drainage line to the north-east. From the DHI Black Creek Flood study:

- The business park (Stage 1) fronting Vincent Street is not affected by flooding up to and including the 1% AEP flood event.
- A small portion of this area (the northern-most two lots) is affected by the PMF.

Although partially affected by the PMF and therefore considered flood liable, this area is not affected by flooding up to and including the 1% AEP event. These lots are not considered to be at sufficient risk to warrant filling or earthworks due to flood considerations. Some earthworks (unrelated to flooding) may however be undertaken as a part of construction on each lot to assist with meeting developer and/or user requirements.

3.3.2 Business Park – western zone adjacent to Black Creek

Based on the existing flood envelopes:

- Approximately 52% of the business park (stage 2 / 3) zone would be impacted by the 1% AEP flood envelope.
- Approximately 85% of the business park (stage 2 / 3) zone would be impacted by the PMF envelope.

As discussed in Section 2.3, although there is not necessarily a prescribed flood planning level for commercial / industrial areas, it is proposed that the business park zone (Stage 2 / 3) will be filled to provide sufficient building area that is at or above the 1% AEP flood level.

3.3.3 Land with residential potential

Based on the existing flood envelopes:

- Approximately 30% of the land with residential potential would be impacted by the 1% AEP flood envelope.
- Approximately 80% of the land with residential potential would be impacted by the PMF envelope.

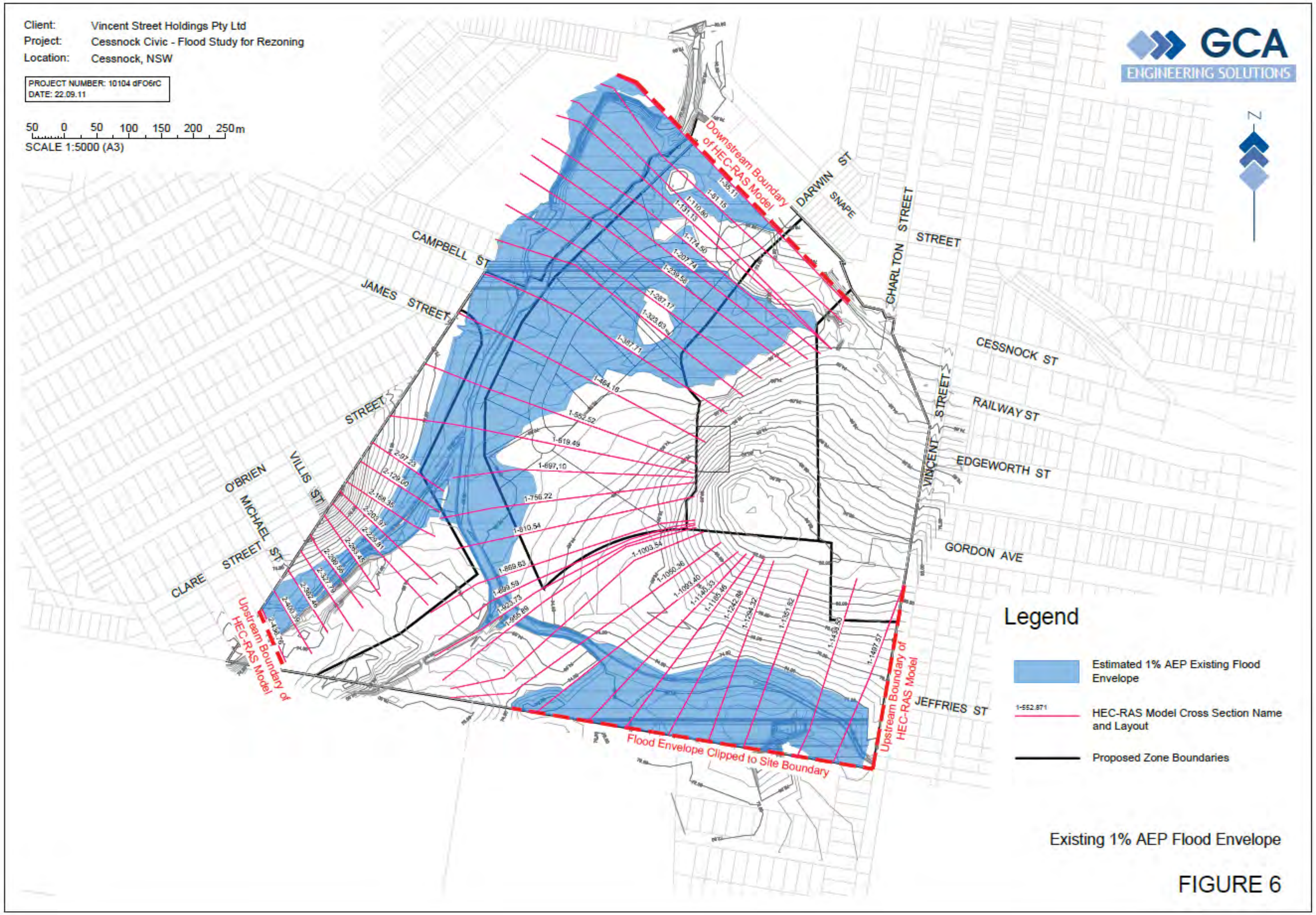
If proposed for residential zoning in future, this land would require earthworks (filling) to achieve lot areas above the 1% AEP flood level, which would also require raising road areas to obtain suitable lot access arrangements and an overall practical engineering solution.

3.3.4 Comparison with DHI Flood Study

Figure 8 shows a comparison between GCA (HEC-RAS) and DHI flood levels for the 1% AEP event. This figure demonstrates that the GCA (HEC-RAS) estimated flood envelope is a very close match to the DHI-estimated 1% AEP flood envelope. Spot flood levels are provided at selected locations, with results differing generally no more than +/- 0.15m. This is with the exception of the area to the south east of the site, where the DHI and HEC-RAS models may have used different DTM's. Interestingly, the flood envelopes are still similar.

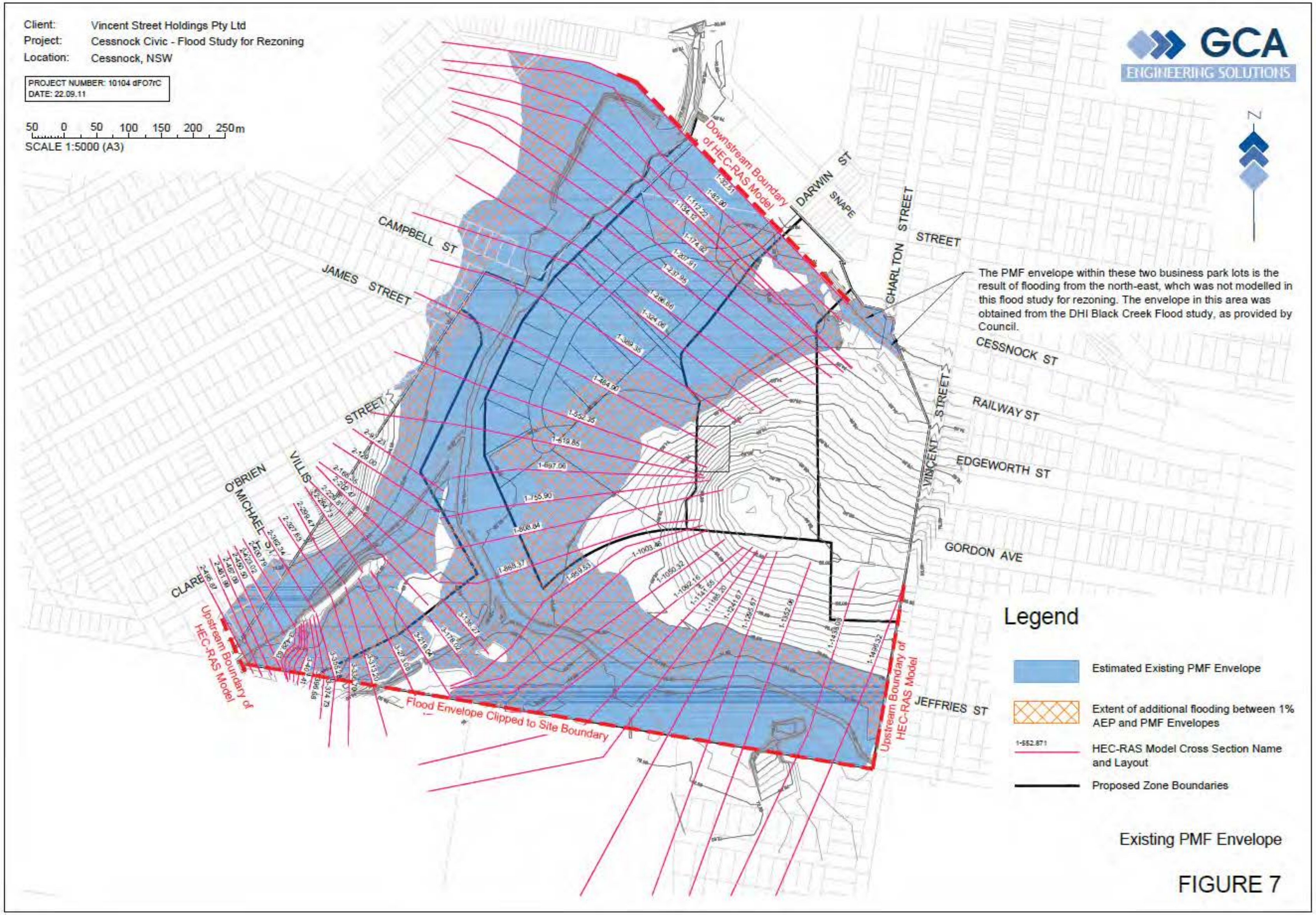
Note that the DHI results for the PMF had been rounded to the nearest whole metre for flood mapping purposes. This is not of sufficient resolution to compare the HEC-RAS and DHI model results at locations within the site, and has therefore not been included in this report.

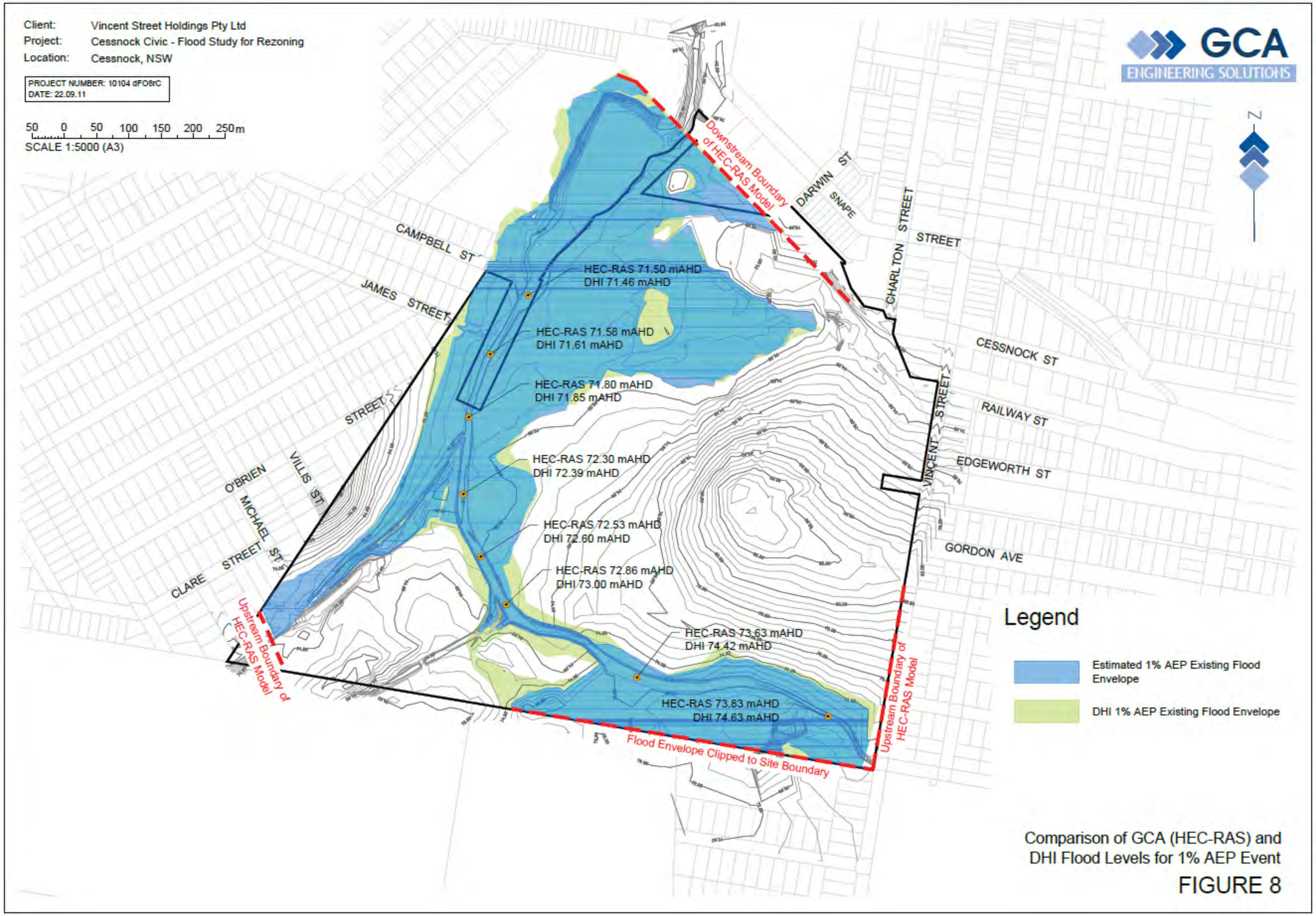
Full HECRAS model output is provided in Appendix C



Existing 1% AEP Flood Envelope

FIGURE 6


Client: Vincent Street Holdings Pty Ltd
Project: Cessnock Civic - Flood Study for Rezoning
Location: Cessnock, NSW
PROJECT NUMBER: 10104 dFO7rC
DATE: 22.09.11
50 0 50 100 150 200 250m
SCALE 1:5000 (A3)
GCA
ENGINEERING SOLUTIONS
N
Downstream Boundary of HEC-RAS Model
Upstream Boundary of HEC-RAS Model
Flood Envelope Clipped to Site Boundary
DARWIN ST
SNAPE
CHARLTON STREET
STREET
CAMPBELL ST
JAMES STREET
STREET
VILLIS
O'BRIEN
MICHAEL ST
CLARE
CESSNOCK ST
RAILWAY ST
VINCENT STREET
EDGEWORTH ST
GORDON AVE
JEFFRIES ST
The PMF envelope within these two business park lots is the result of flooding from the north-east, whch was not modelled in this flood study for rezoning. The envelope in this area was obtained from the DHI Black Creek Flood study, as provided by Council.
Legend
Estimated Existing PMF Envelope
Extent of additional flooding between 1% AEP and PMF Envelopes
1-552.871
HEC-RAS Model Cross Section Name and Layout
Proposed Zone Boundaries
Existing PMF Envelope
FIGURE 7



Comparison of GCA (HEC-RAS) and DHI Flood Levels for 1% AEP Event

FIGURE 8

4. Developed flood conditions

This section describes the results from flood modelling using the landform model depicted in Appendix B.

4.1 Model parameters

The development will involve filling within the flood affected areas to provide lots with a sufficient level of flood immunity, as described in Section 2.3. Areas that are outside of the 1% AEP envelope may also be subject to earthworks in order to obtain material for the filling within the Cessnock Civic precinct. It is understood that there may not be a balance between cut and fill, ultimately requiring material to be sourced from off-site.

The proposed post-development landform was modelled in HEC-RAS. The cross section layout for the drainage line through the land with residential potential was varied for the post-development 1% and PMF models, to take into account potential for future augmentation of the local drainage line that will carry flow rates from the upstream rehabilitated mine landform.

Other model parameters for regime, boundary conditions, flow rates, and energy loss coefficients were retained from the existing scenario model.

A culvert structure, consisting of (8) x 1800mm diameter culverts, was included under the road between the western and eastern portions of the land with residential potential. These culvert sizes were arbitrarily adopted and may vary as part of any future proposal in this area.

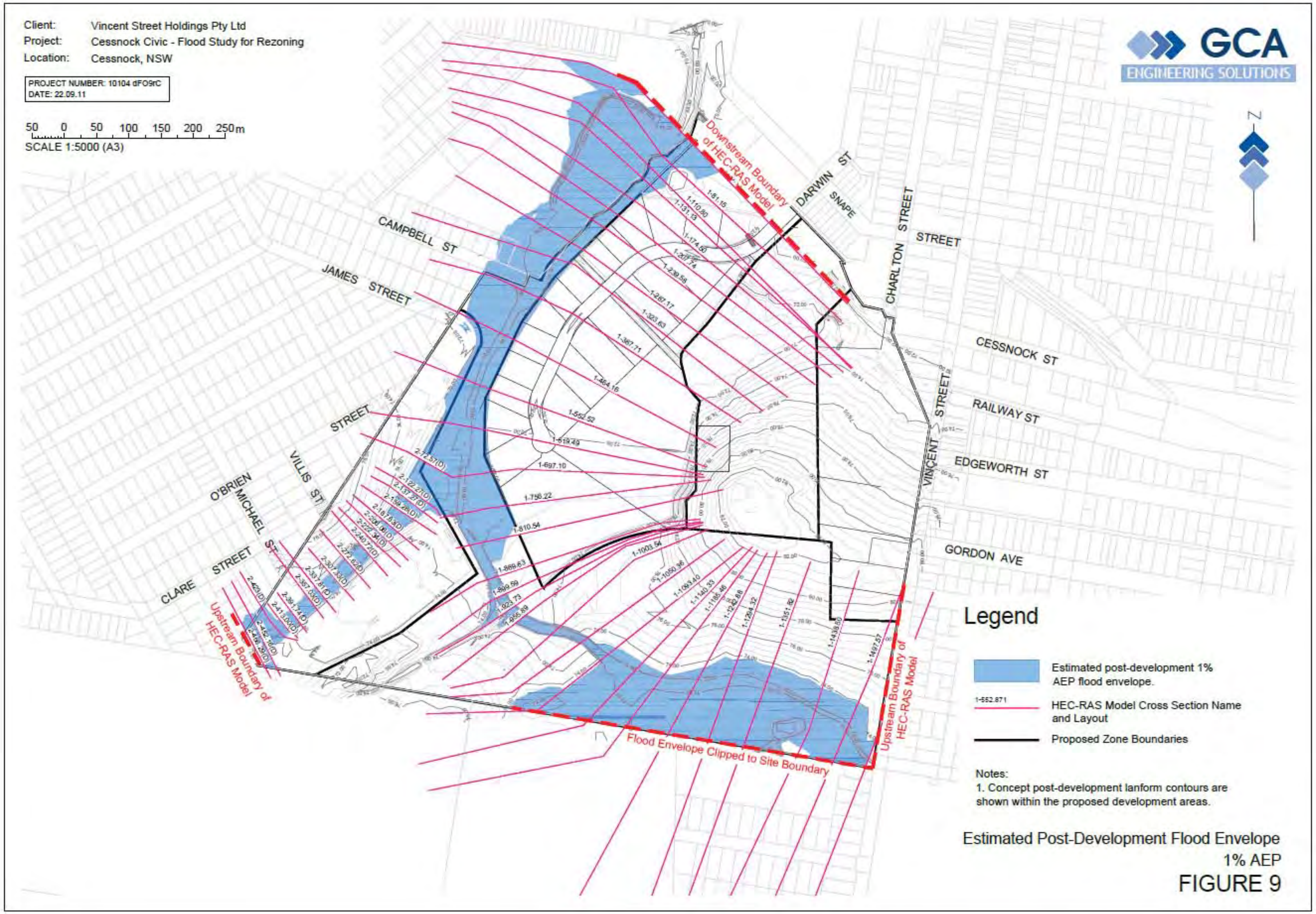
4.2 Developed flood levels

Full HEC-RAS model results for developed and existing scenarios is provided in Appendix C. Refer to Figures 9 and 10 for model cross section locations.

Figures 9 and 10 show the estimated post-development flood envelopes for the 1% AEP event and the PMF, based on the concept proposed landform design.

The envelopes demonstrate that the overall flood planning level objectives (described in Section 2.3) can be achieved by the concept landform.

Figure 11 shows the difference between existing and post-development 1% AEP flood envelopes across the site. The model results also show that the reduction in cross sectional area of Black Creek may impact flood levels locally within the site. However, the increases are attenuated prior to reaching the upstream site boundaries. The local increase in flood levels will only therefore impact the planning and design of development within the Cessnock Civic precinct, and will not impact surrounding properties.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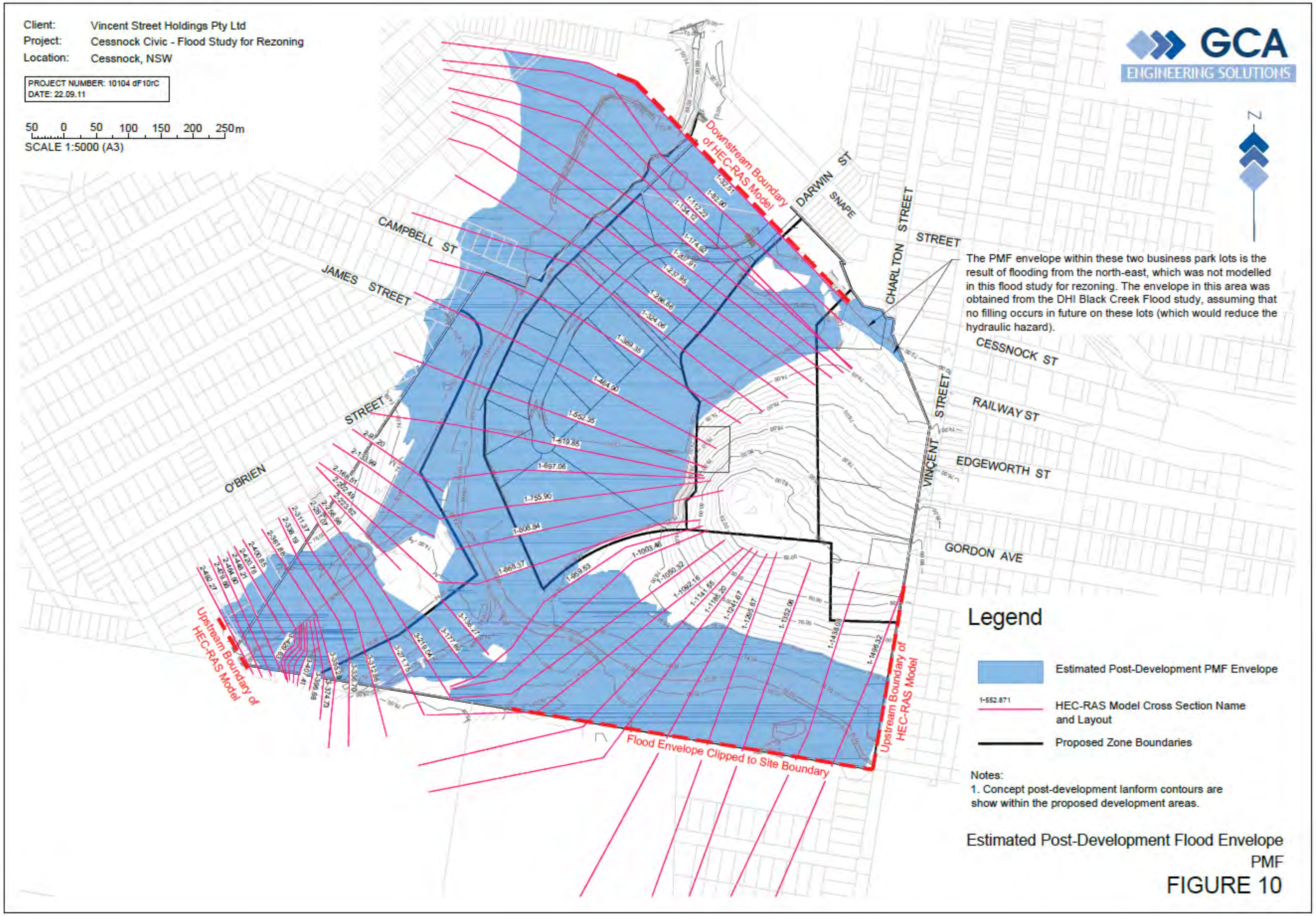
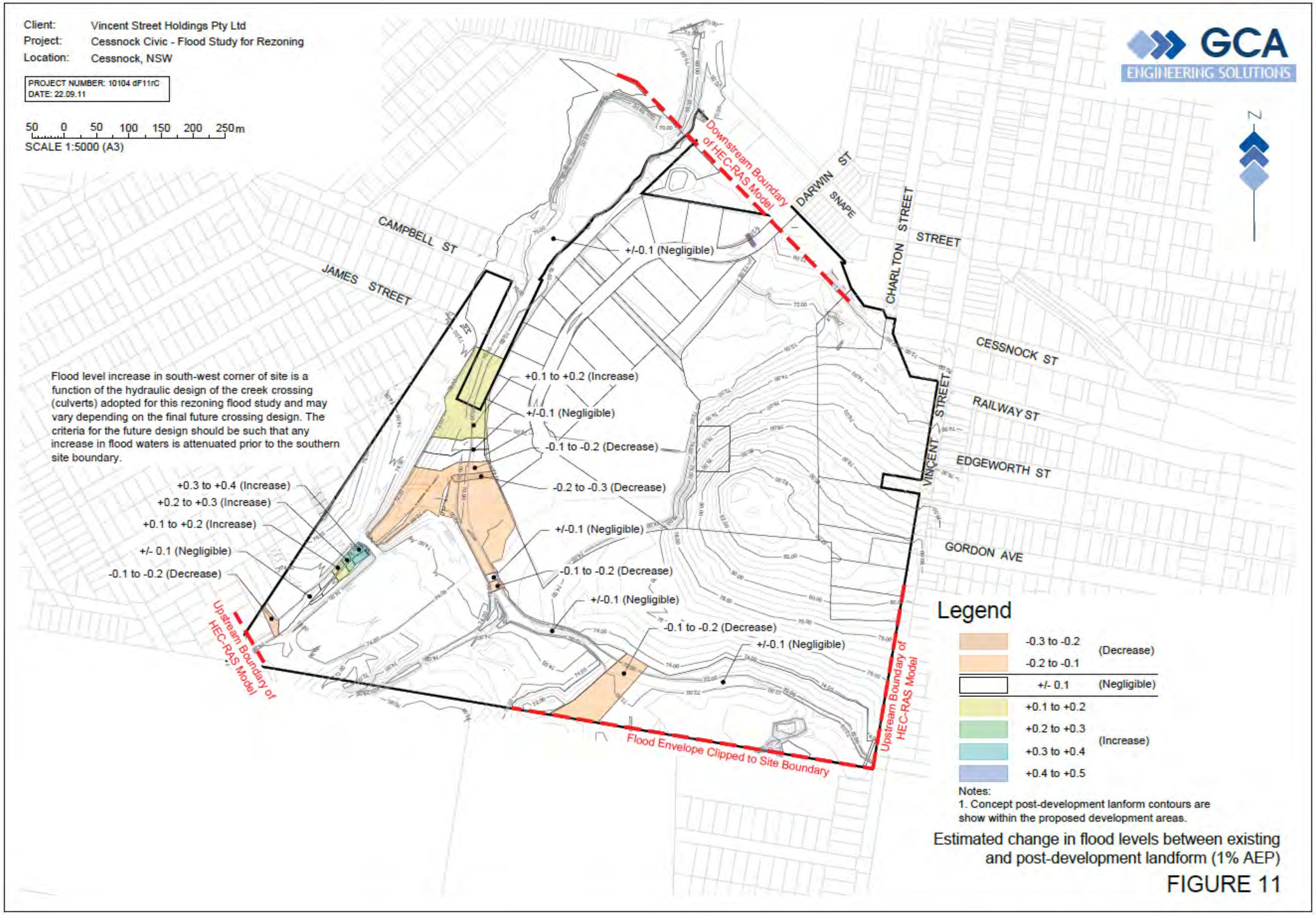
Project: Cessnock Civic - Flood Study for Rezoning
Location: Cessnock, NSW
PROJECT NUMBER: 10104 dFO9rC
DATE: 22.09.11
50 0 50 100 150 200 250m
SCALE 1:5000 (A3)
GCA ENGINEERING SOLUTIONS
N
Downstream Boundary of HEC-RAS Model
Upstream Boundary of HEC-RAS Model
Flood Envelope Clipped to Site Boundary
Upstream Boundary of HEC-RAS Model
DARWIN ST
SNAPE
CHARLTON STREET
CAMPBELL ST
JAMES STREET
CESSNOCK ST
RAILWAY ST
VINCENT STREET
EDGEWORTH ST
GORDON AVE
STREET
VILLIS ST
O'BRIEN
MICHAEL ST
CLARE STREET
Legend
Estimated post-development 1% AEP flood envelope.
HEC-RAS Model Cross Section Name and Layout
Proposed Zone Boundaries
Notes:
1. Concept post-development lanform contours are shown within the proposed development areas.
Estimated Post-Development Flood Envelope
1% AEP
FIGURE 9



Estimated Post-Development Flood Envelope
PMF
FIGURE 10



Estimated change in flood levels between existing and post-development landform (1% AEP)

FIGURE 11

4.3 Floodplain storage

The PB study provided a discussion of floodplain storage, which is reproduced as follows:

> *Preliminary volumetric analysis indicates that there could be around 300,000m of flood water stored within the site between the existing natural surface level and the peak 1% AEP flood level. The floodplain storage volume between the concept earthworks model and the peak developed 1% AEP flood level is approximately 245,000m^3. This corresponds to a reduction in flood storage of approximately 55,000m^3.*
>
> *Assuming a runoff coefficient of 0.2 (typical for undeveloped natural catchments), a runoff volume of 9.33x10^8 m^3 could be generated from the 2,940ha upstream catchment during the 1% AEP (720 min duration) design rainfall event [design rainfall depth 156.6mm]. The volume of flood storage within the site represents only 0.03% of this estimated event runoff volume. Since the flood storage is an insignificant part of the total event volume, the site is unlikely to provide any temporary storage for flood flow rate attenuation. This means that the flood levels within the site and upstream are directly related to the hydraulic head required to convey flood flow rates. It is therefore highly unlikely that the reduction in flood storage would have an adverse impact on flow rates or flood levels on surrounding properties, upstream, or downstream. (PB, June 2010)*

Although the figures quoted by PB will vary slightly to that resulting from the engineering solution presented in this report, the orders of magnitude are equivalent and the overall conclusions in respect to floodplain storage are still appropriate.

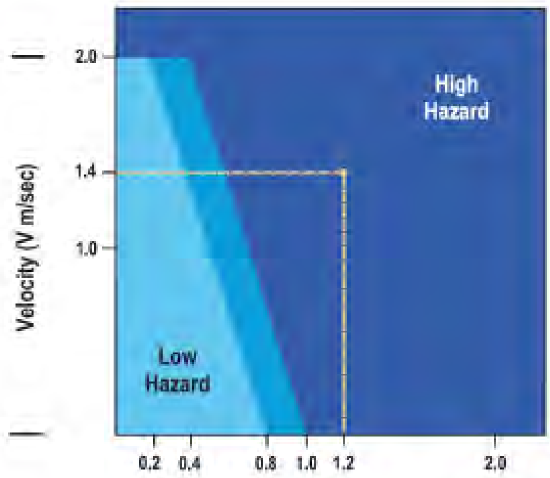
4.4 Flood Hazard

This section discusses flood hazard considerations for the proposed business park zone and land with residential potential.

4.4.1 Hydraulic hazard

The hydraulic hazard associated with a flood is represented by the static and dynamic energy of the flow, ie the depth and velocity of the floodwaters. Therefore, these two factors provide key insight into the likely hazard associated with a particular flood event.

The hydraulic flood hazard is a measure of the degree of difficulty that pedestrians and motor vehicles will encounter during egress from flooded areas, and the likely damage to property and infrastructure. Sections of land classed as "low hazard" are areas where (should it be necessary) trucks could evacuate people and their possessions and able-bodied adults would have little difficulty in wading to safety. Areas are classified as "high hazard" where this could not occur and damage to structures is more likely. The NSW Floodplain Development Manual provides provisional hydraulic hazard categories based on the combination of depth and velocity at a site, which are reproduced below.



The velocity and depth profile across each HEC-RAS cross section was taken into consideration and provisional hydraulic flood hazard risk categorisation maps were produced for the 1% AEP and PMF events [refer Figures 12 and 13].

The maps demonstrate that all of the business park lots are all located outside of the 1% AEP flood envelope and therefore considered not at risk up to and including the 1% AEP flood event. A reasonable portion of the area with residential potential is also located outside of the 1% AEP flood envelope for the adopted conceptual landform.

A large proportion of the western business park zone adjacent to Black Creek and land with residential potential will be associated with a 'high' provisional hazard category. This is primarily the result of deep water (>1m) of very low velocity (<0.5m/s). There is a clear egress path from the Business Park zone through Darwin Street to higher ground on Vincent Street, less than 500m away from the zone boundary. Egress paths for the land with residential potential would be subject to assessment as part of a future rezoning proposal.

Note that the 'true' hazard requires consideration of various other factors as discussed in Appendix L of the NSW Government Floodplain Development Manual 2005. These additional factors include: available warning time, time of inundation, and access conditions. In general, the Floodplain development manual is not prescriptive, and relies on local flood risk management committees to set the relevant parameters ultimately balancing risk against the economic benefits of occupying the land. Where no committee has been established, development decisions will need to be made with reference to the above and specific flood risk management advice [refer Section 4.4.2]. It is noted however that this flood study does not constitute a flood risk management plan, which should only be undertaken on a holistic regional scale and not on an individual development basis.

4.4.2 Other factors

Other factors that could potentially work to reduce the actual flood hazard during extreme events are discussed below. It is again emphasized that this is only applicable during extreme events, as all proposed business park lots will be flood free up to and including the 1% AEP flood event.

Rate of rise, warning time and duration of inundation

Flood hydrographs from the DRAINS model (and as noted from the DHI Black Creek Flood Study) indicate that the time to peak flood is about 6 hours for the PMF. Egress procedures, education and flood readiness will be important considerations for the development. This is equally applicable to the surrounding existing development areas that are also flood liable. The site should therefore be incorporated into the regional flood risk management and emergency response plan that is to be commissioned by Council in the future.

The recession time in the flood hydrograph responds almost as quickly as the rising limb, with the vast majority of the flooding expected to be reduced below the 1% AEP level within a matter of hours.

Egress route

As stated earlier, there are egress routes available to higher ground from the business park zone and land with residential potential. A continuously rising route is likely to be a consideration for any future proposed development within the land with residential potential.

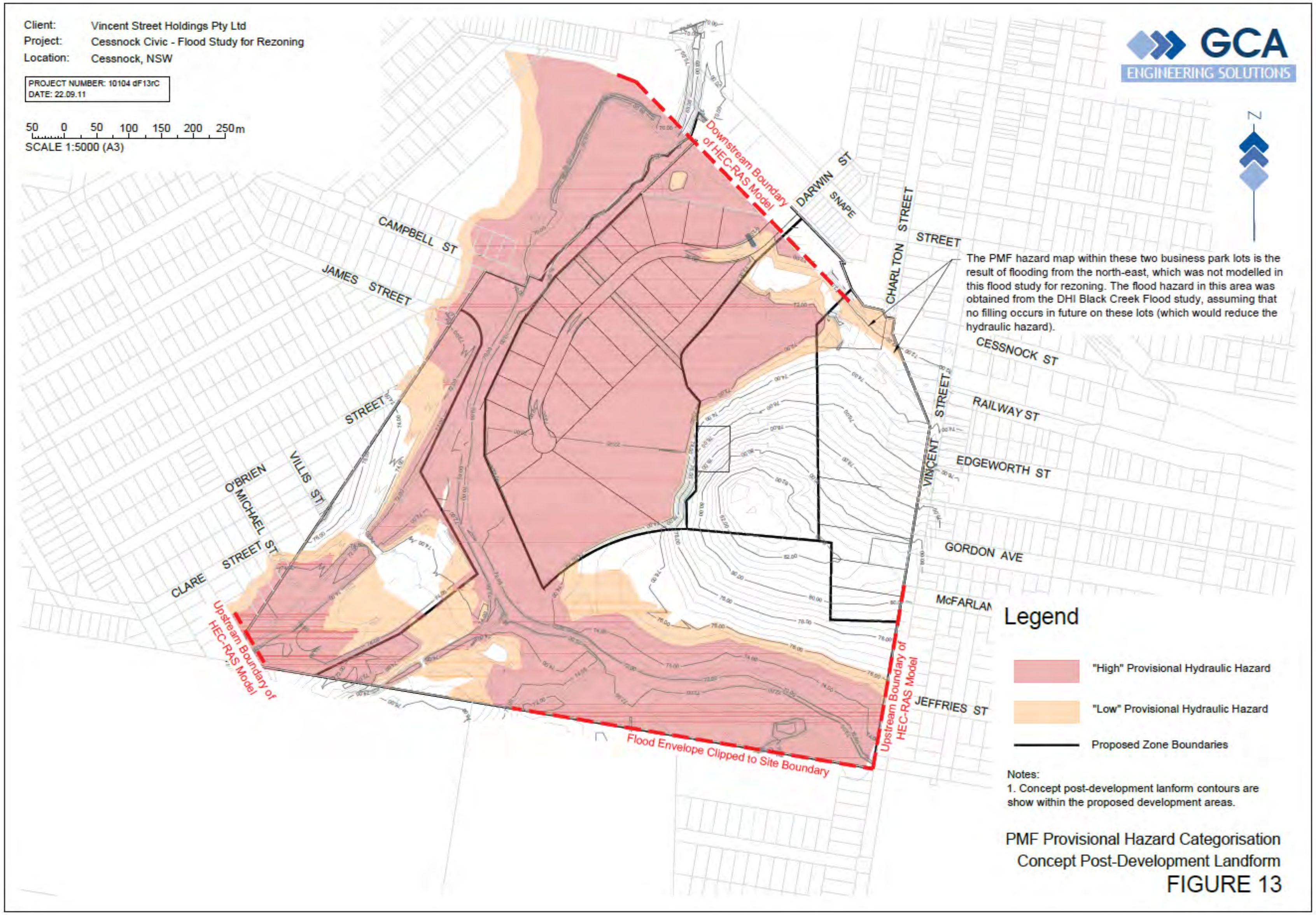
Obstructions to flow causing high localised velocities

The majority of flooding within the site is a function of backwater, which has relatively high depth and very low velocity. Thus, high localised velocities should only be an issue within the creeklines only, and not on the business park lots.

4.5 Limitations

Refer to Appendix D for a statement on study limitations.

1% AEP Provisional Hazard Categorisation
Concept Post-Development Landform
FIGURE 12



PMF Provisional Hazard Categorisation
Concept Post-Development Landform
FIGURE 13

5. Conclusions and recommendations

The proposed Cessnock Civic development site is situated within the Black Creek catchment upstream of the township of Cessnock. The site is proposed for rezoning into business park, rural and environmental land uses. A portion of the site has been identified as having residential potential (and has been included in this flood study as such), but has not been proposed for rezoning as part of the current rezoning proposal.

The site is affected by flooding from Black Creek. The existing 1% AEP flood envelope affects 50% of the western business park zone and 30% of the land with residential potential.

The PMF envelope affects approximately 85% of the western business park zone adjacent to Black Creek and 80% of the land with residential potential. There is an egress route available from the western business park zone through to 'flood free' areas on Vincent Street, approximately 500m along Darwin and Snape Streets. Egress routes for the land with residential potential would be subject to further assessment as part of a future land rezoning proposal.

This report has examined a conceptual site earthworks option that was produced with the aim of achieving:

- For business park zone: lots less than 5000m^2 in area have at least 80% of the lot area at or above the design 1% AEP flood level, and lots greater than 5000m^2 in area are to have at least 50% of the lot area at or above the design 1% AEP flood level. The future construction of buildings will be such that the building finished floor levels are at or above the 1% AEP flood level.
- For the land with residential potential: sufficient building area on each lot so that dwellings can be constructed with 0.5m freeboard to the 1% AEP flood level using standard building construction practices and without requiring excessive additional earthworks during dwelling construction.

This study has assumed that no works would be undertaken within the Black Creek main channel other than associated with works on the side drainage line through the land with residential potential, which may be undertaken in future.

HEC-RAS modelling of the potential solution has predicted that the proposed extent of earthworks would not increase flood levels upstream of the proposed development site during the 1% AEP event.

From the Probable Maximum Flood Envelopes, evacuation egress paths are available for both the business park zone. It would be appropriate that this site is included in the emergency response plans (to be produced by Cessnock Council for the wider Cessnock area).

Appendix A

DRAINS Hydrologic Model

GCA ENGINEERING SOLUTIONS

Cessnock Civic
Flood Study for Rezoning

Appendix A - DRAINS Model Subcatchment Data
J/N 10104 14-Feb-11

SUB-CATCHMENT DETAILS

Subcatchment	Total Area (ha)	Impervious Area %	Average Slope(%)
A	247.5	0.0%	4.1
B	360	0.0%	3.8
C	157.5	2.5%	3.5
D	130	0.0%	4.3
E	127.5	7.6%	0.8
F	267.5	0.0%	3.5
G	218.8	0.0%	1.5
H	140.6	5.0%	0.6
I	130	0.0%	1
J	190.6	0.0%	2.7
K	103.8	0.0%	2.6
L	183.1	2.1%	2.2
M	105.4	12.0%	1.5
N	39.2	37.0%	4

LINK DETAILS

From	To	Travel Time (min)
A	J1	2.5
B	J1	5.5
C	E	8
D	J2	8.3
E	G	15
F	G	11.1
G	H	15
H	J4	5
I	J4	1.1
J	L	20
J1	J2	7.2
J2	E	5
J4	J5	5.6
J5	M	10
K	L	18.9
L	N	4.5
N	J5	1.7

RAFTS HYDROLOGY

Initial Loss (mm)	30
Continuing Loss (mm/hr)	2.7
Bx	1.9

Appendix A - DRAINS Model Subcatchment Data.xlsx 17/02/2011 6:17 PM

Cessnock Civic
Flood Study for Rezoning
Appendix A - DRAINS Model Subcatchment Data
J/N 10104 14-Feb-11

PMP RAINFALL CALCULATIONS

LOCATION INFORMATION

Catchment	Black Creek Cessnock / Aberdare		Area	24	km^2
State	NSW		Duration limit	6	hrs
Latitude			Longitude		
Smooth, S =	1.0	(0.0 - 1.0)	Rough, R =	0.0	(0.0 - 1.0)

ELEVATION ADJUSTMENT FACTOR (EAF)

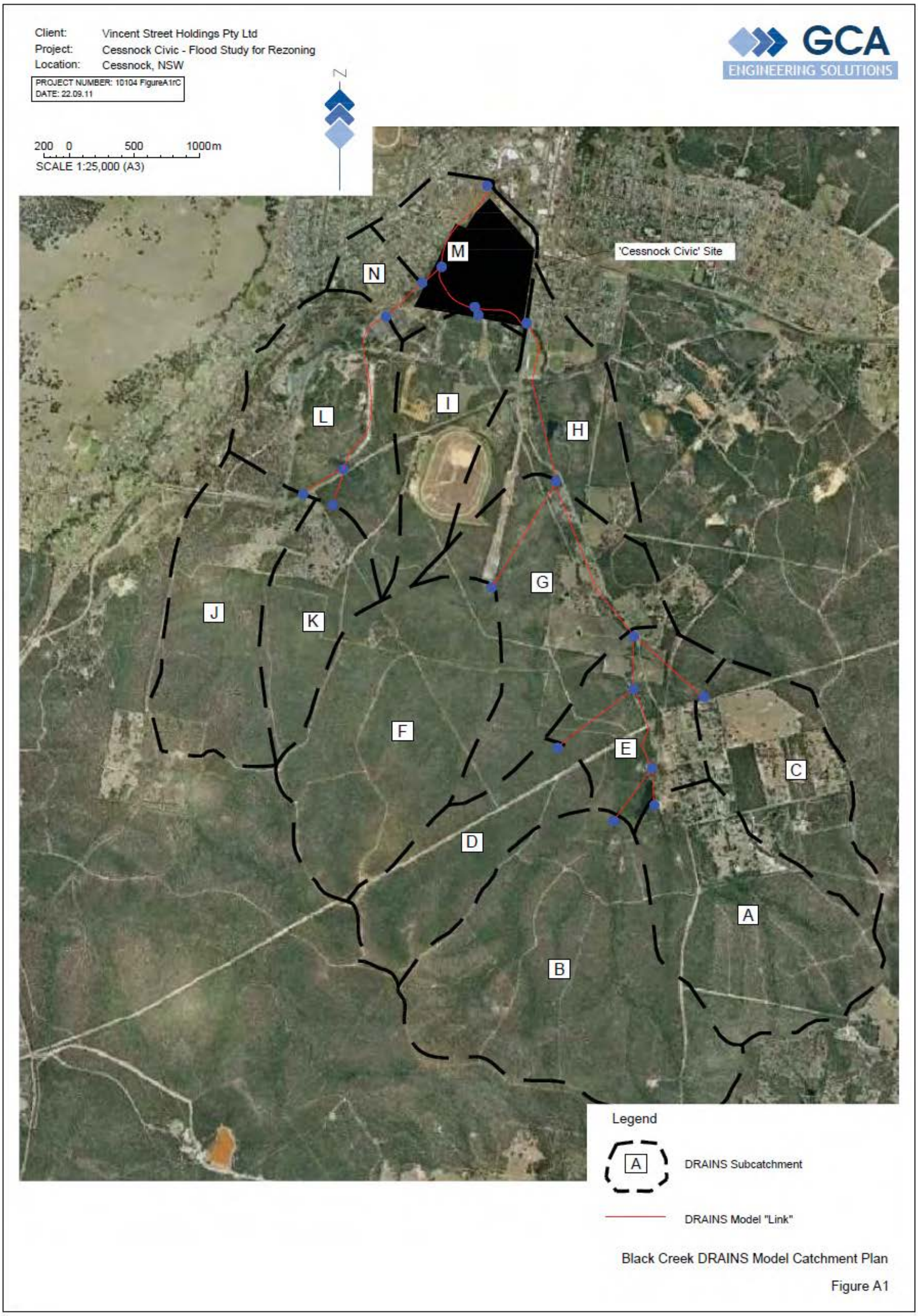
Mean Elevation	100	(m)
Adjustment for Elevation	0.00	(-0.05 per 300m above 1500m)
EAF =	1.00	(0.85 - 1.00)

MOISTURE ADJUSTMENT FACTOR (MAF)

MAF =	0.73	(0.4 - 1.0)

Duration (hours)	Initial Depth - Smooth (Ds)	Initial Depth - Rough (DR)	PMP Estimate (DSxS+DRxR)xMAFxEAF	Rounded PMP Estimate (nearest 10mm)
0.25	190	190	138.7	140
0.50	290	290	211.7	210
0.75	365	365	266.45	270
1.00	430	430	313.9	310
1.50	495	560	361.35	360
2.00	560	650	408.8	410
2.50	595	725	434.35	430
3.00	625	785	456.25	460
4.00	695	900	507.35	510
5.00	750	990	547.5	550
6.00	795	1050	580.35	580

Appendix A - DRAINS Model Subcatchment Data.xlsx 17/02/2011 5:17 PM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Project: Cessnock Civic - Flood Study for Rezoning
Location: Cessnock, NSW
PROJECT NUMBER: 10104 FigureA1rC
DATE: 22.09.11
200 0 500 1000m
SCALE 1:25,000 (A3)
N
GCA
ENGINEERING SOLUTIONS
'Cessnock Civic' Site
M
N
I
L
H
G
J
K
F
E
C
D
A
B
Legend
A
DRAINS Subcatchment
DRAINS Model "Link"
Black Creek DRAINS Model Catchment Plan
Figure A1

Appendix B

Existing and Proposed Land Forms

FUTURE SUBDIVISION

BUSINESS PARK (AND LAND WITH RESIDENTIAL POTENTIAL)

CESSNOCK CIVIC PRECINCT

EXISTING SITE AND CONCEPT POST-DEVELOPMENT LANDFORM PLANS

REZONING PHASE

CESSNOCK CITY COUNCIL

DWG No.	SHEET TITLE	REV
C00	COVER SHEET	2
C01	GENERAL ARRANGEMENT PLAN	2
C02	EXISTING LANDFORM (NATURAL CONTOURS)	2
C03	CONCEPT LANDFORM PLAN SHEET (1 OF 2)	2
C04	CONCEPT LANDFORM PLAN SHEET (2 OF 2)	2
C05	1% AEP FLOOD ENVELOPE FOR CONCEPT LANDFORM	2
C06	CROSS SECTION THROUGH LAND WITH RESIDENTIAL POTENTIAL-CROSS SECTION 1 AND 2	2
C07	CROSS SECTION THROUGH LAND WITH RESIDENTIAL POTENTIAL-CROSS SECTION 3 AND 4	2
C08	CROSS SECTION THROUGH LAND WITH RESIDENTIAL POTENTIAL-CROSS SECTION 5 AND 6	2

GCA
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PO BOX 3337, THORNTON NSW 2322
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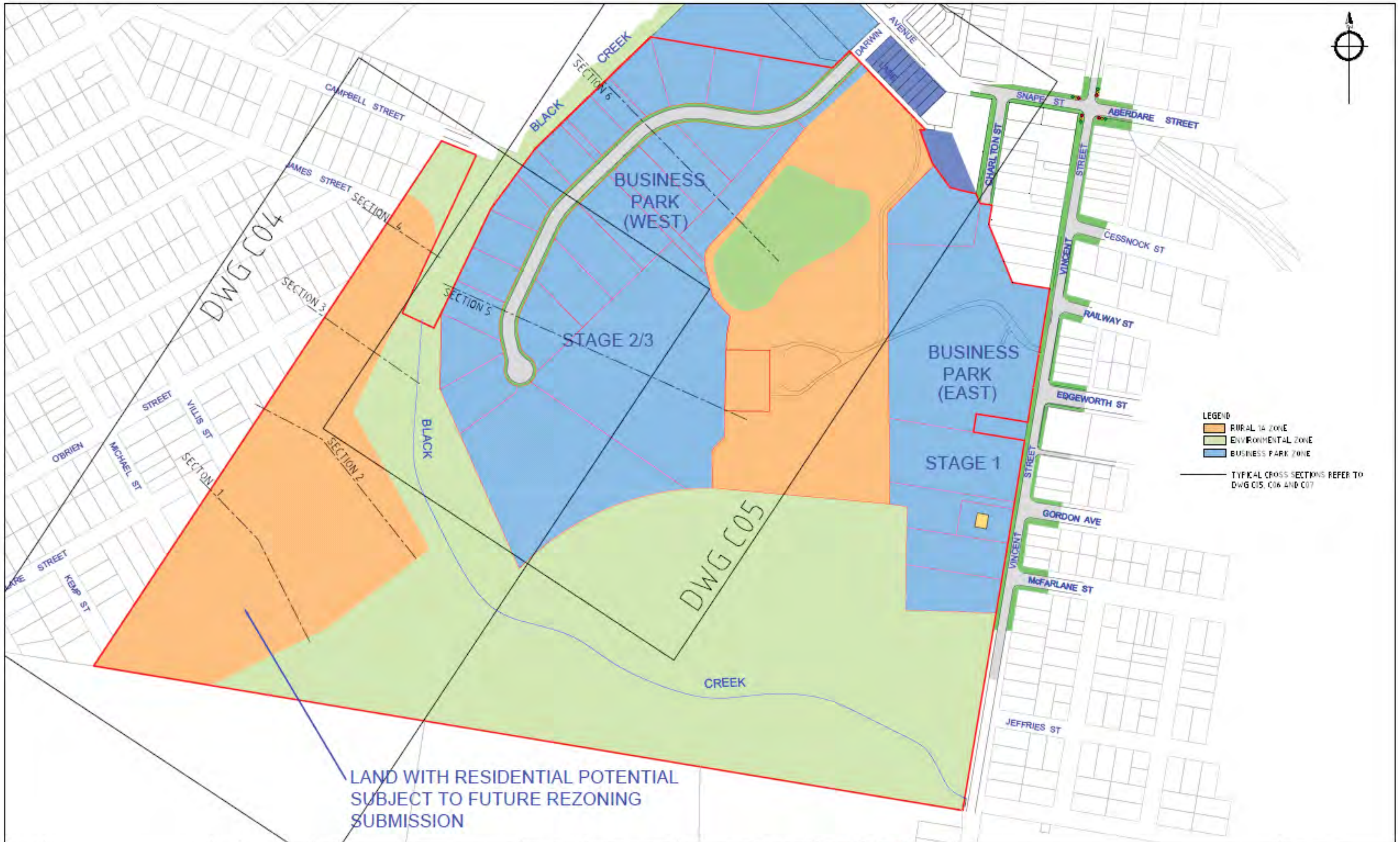

Amendment	Description	Drawn	App'd	Date
2	UPDATED ZONE PLAN	A.S.	A.S.	27.09.11
1	ORIGINAL ISSUE	P.K	A.S	05.02.11

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Cad Reference: 10104CC dC01r1
Scale: 1:4000
A3 SHEET
Project Approval: IAN HILL (B.E) Consulting Civil Engineer

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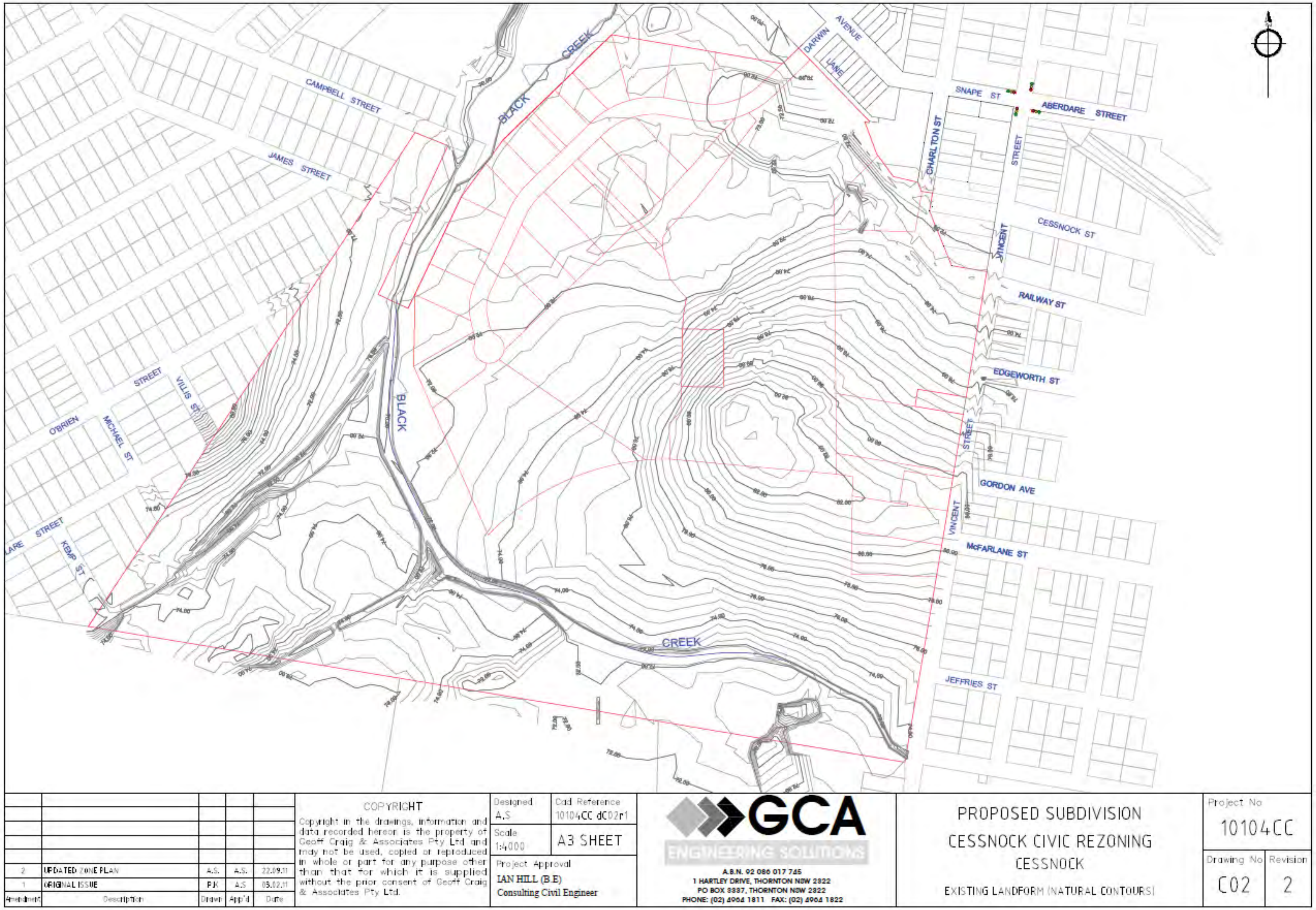
PROPOSED SUBDIVISION
CESSNOCK CIVIC REZONING
CESSNOCK
GENERAL ARRANGEMENT PLAN

Project No: 10104CC
Drawing No: C01
Revision: 2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DARWIN LANE
AVENUE
SNAPE ST
ABERDARE STREET
CHARLTON ST
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CESSNOCK ST
RAILWAY ST
EDGEWORTH ST
GORDON AVE
McFARLANE ST
JEFFRIES ST
VILLIS ST
STREET
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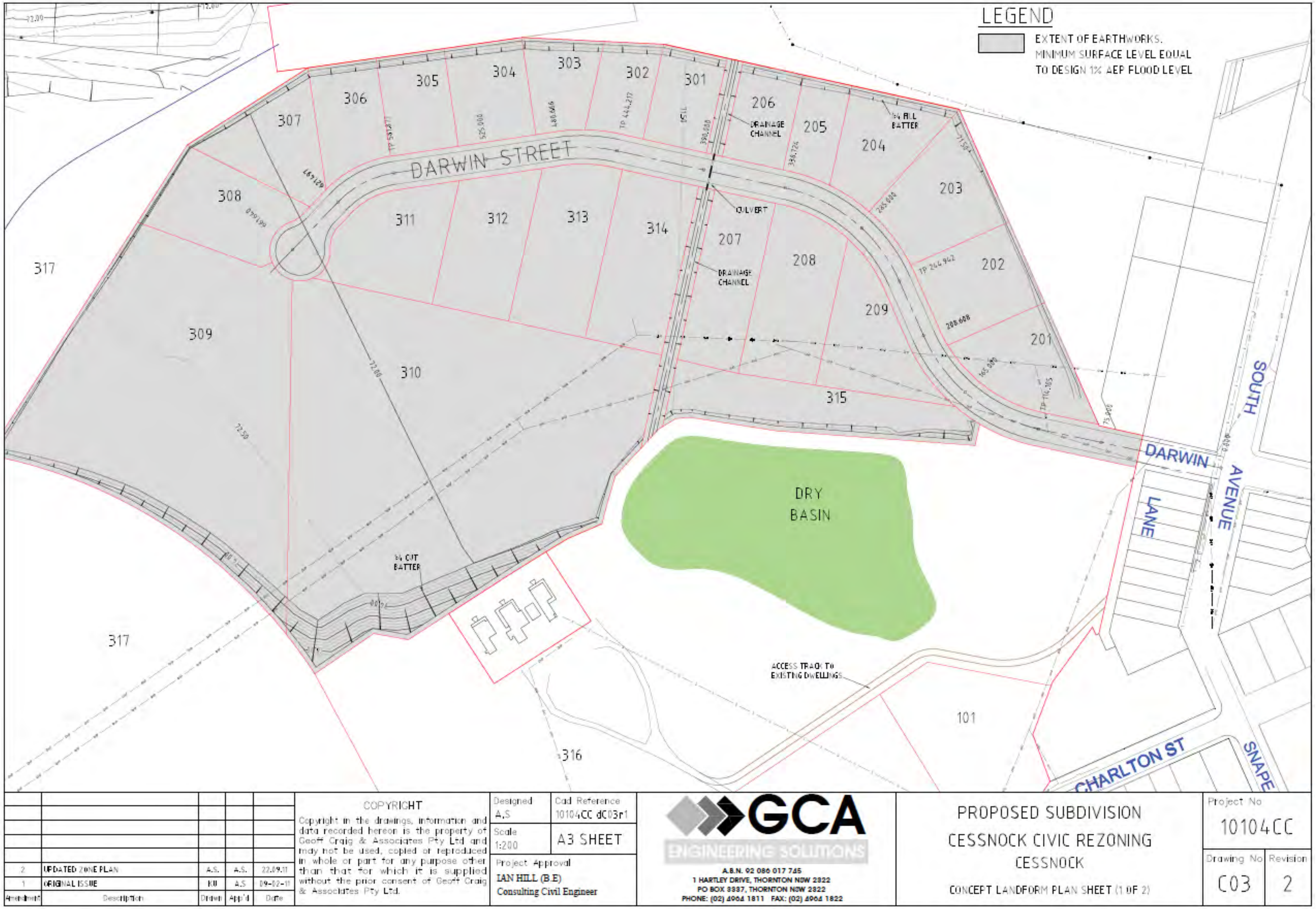
Project No 10104CC
Drawing No C02
Revision 2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EXTENT OF EARTHWORKS.
MINIMUM SURFACE LEVEL EQUAL TO DESIGN 1% AEP FLOOD LEVEL
DARWIN STREET
SOUTH AVENUE
DARWIN LANE
CHARLTON ST
SNAPE
DRY BASIN
ACCESS TRACK TO EXISTING DWELLINGS
CULVERT
DRAINAGE CHANNEL
¼ FILL BATTER
¼ CUT BATTER
101
201
202
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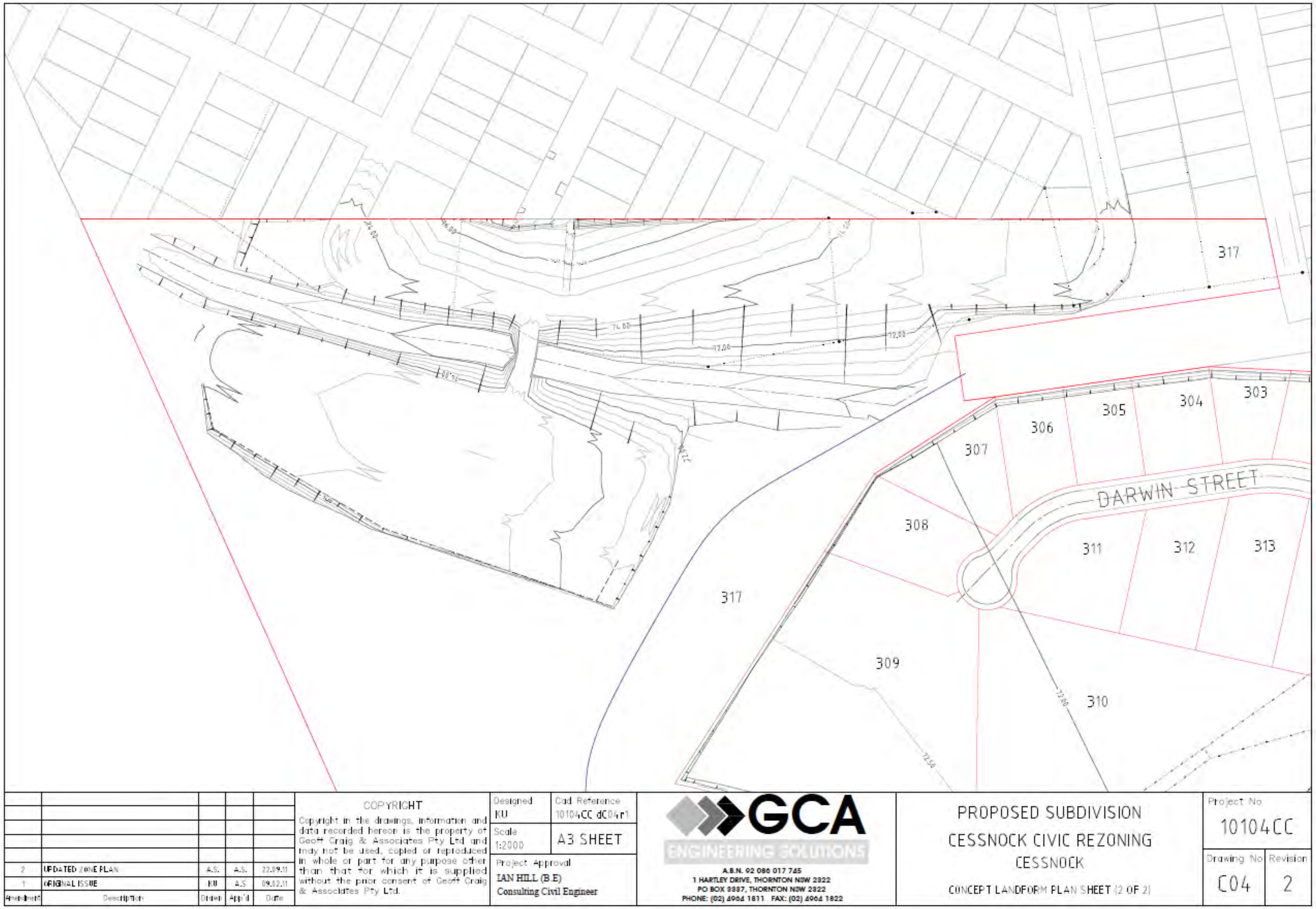
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CONCEPT LANDFORM PLAN SHEET (2 OF 2)
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Drawing No C04
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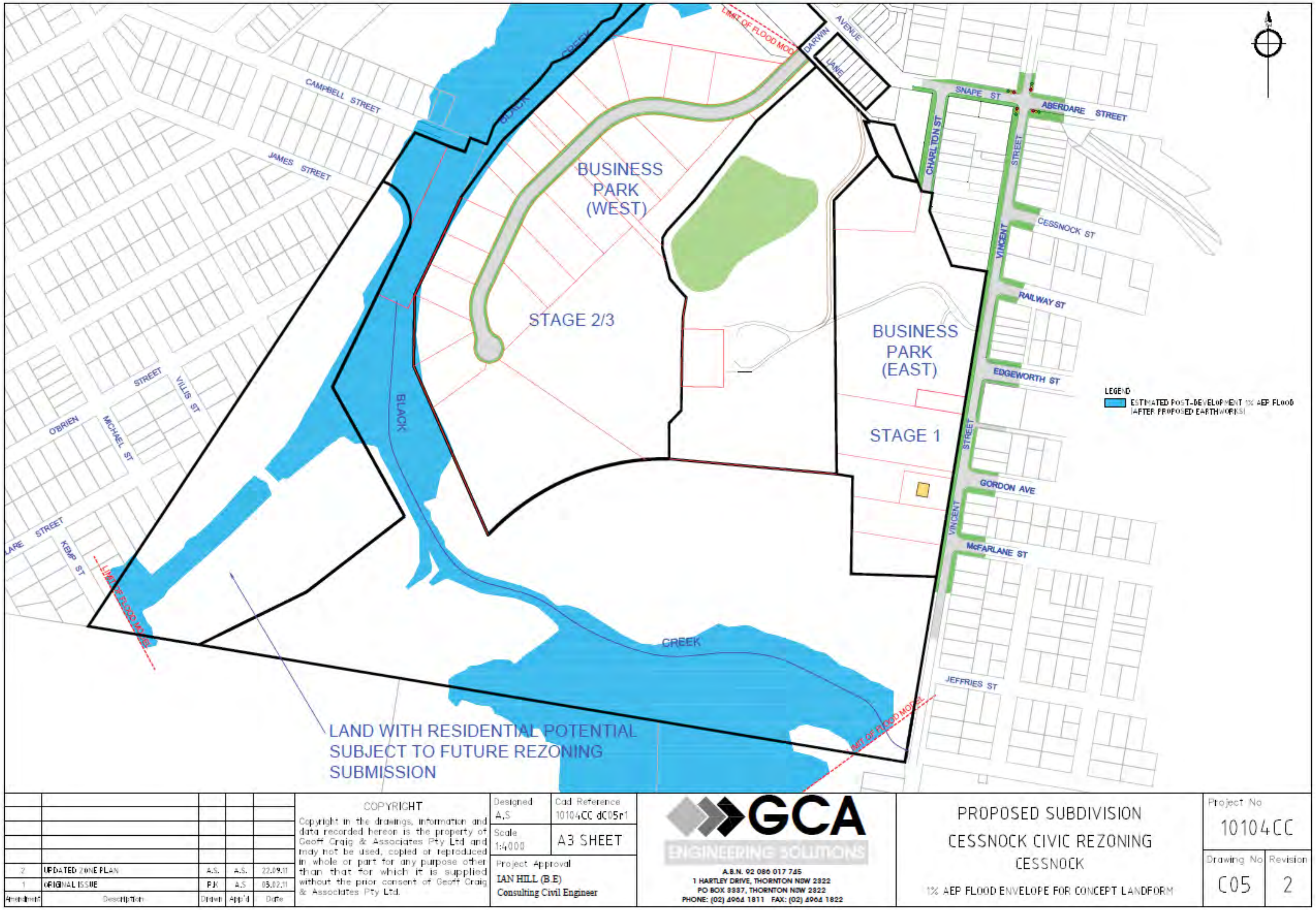
BUSINESS PARK (WEST)
STAGE 2/3
BUSINESS PARK (EAST)
STAGE 1
LAND WITH RESIDENTIAL POTENTIAL SUBJECT TO FUTURE REZONING SUBMISSION
BLACK CREEK
CAMPBELL STREET
JAMES STREET
VILLIS ST
MICHAEL ST
O'BRIEN STREET
KEMP ST
DARWIN AVENUE
LANE
SNAPE ST
ABERDARE STREET
CHARLTON ST
VINCENT STREET
CESSNOCK ST
RAILWAY ST
EDGEWORTH ST
GORDON AVE
McFARLANE ST
JEFFRIES ST
LIMIT OF FLOOD MODEL
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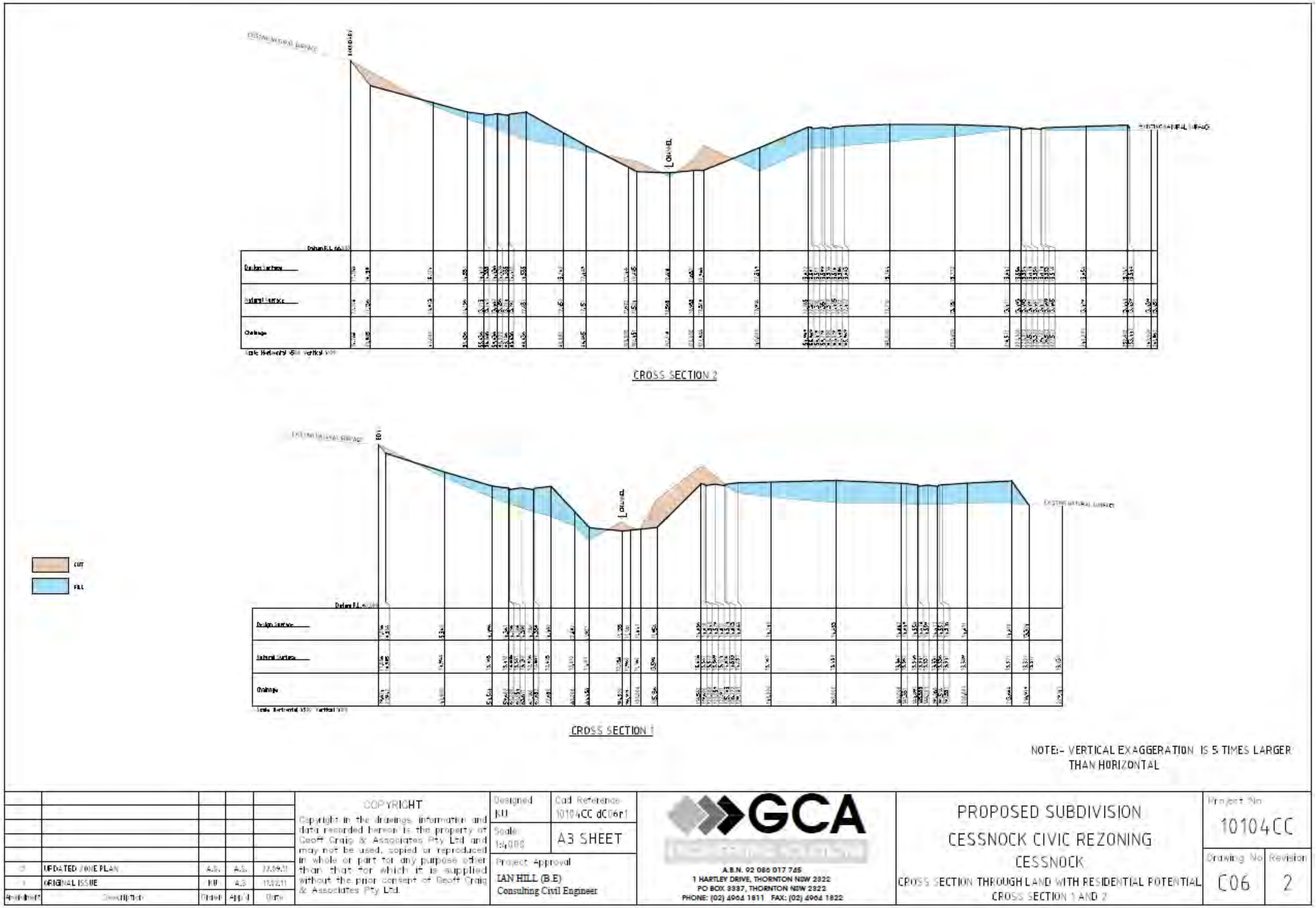
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CHANNEL
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Natural Surface
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CESSNOCK CIVIC REZONING
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CROSS SECTION 1 AND 2
Project No
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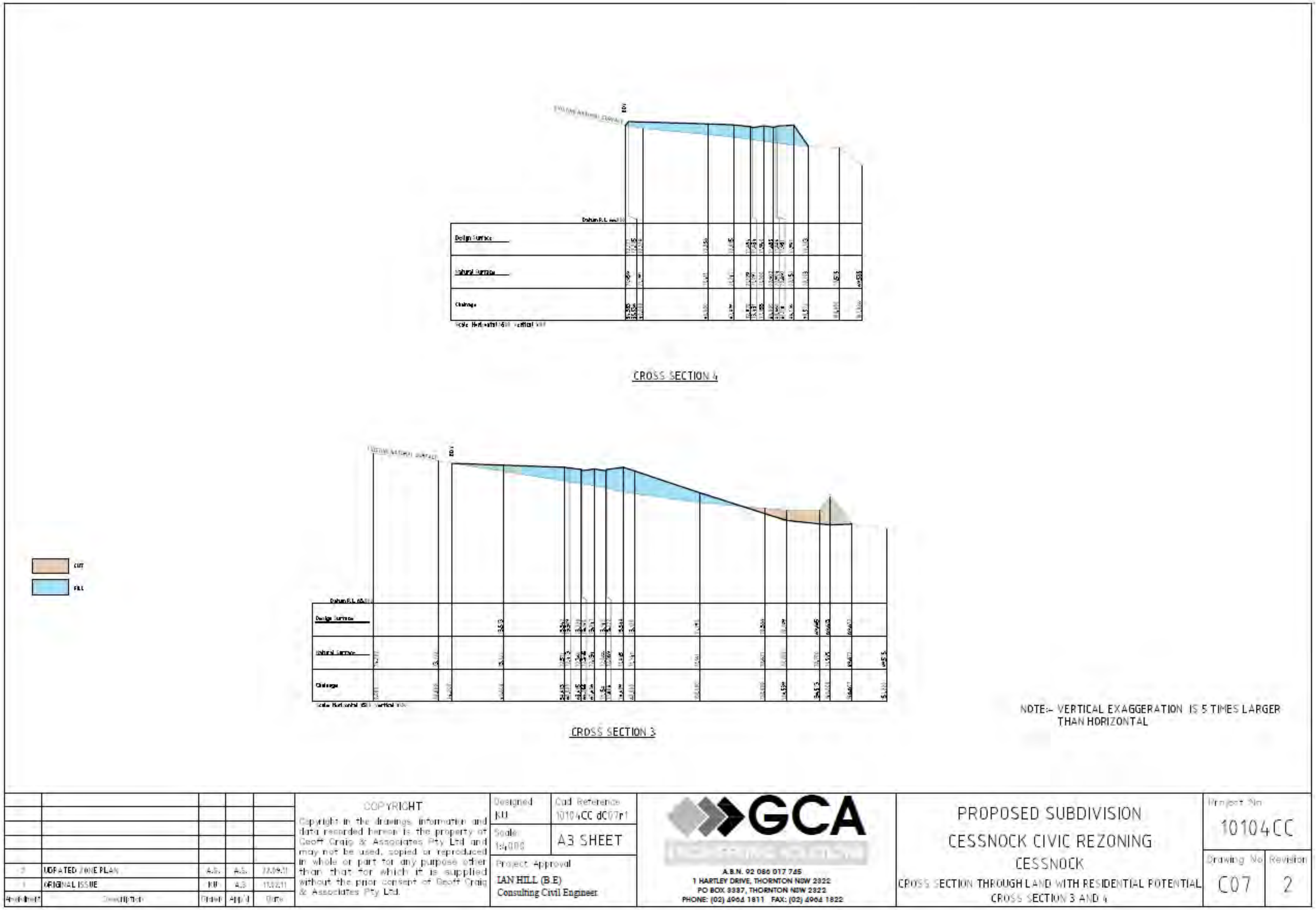
Drawing No
C06
Revision
2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GCA
A.B.N. 92 086 017 745
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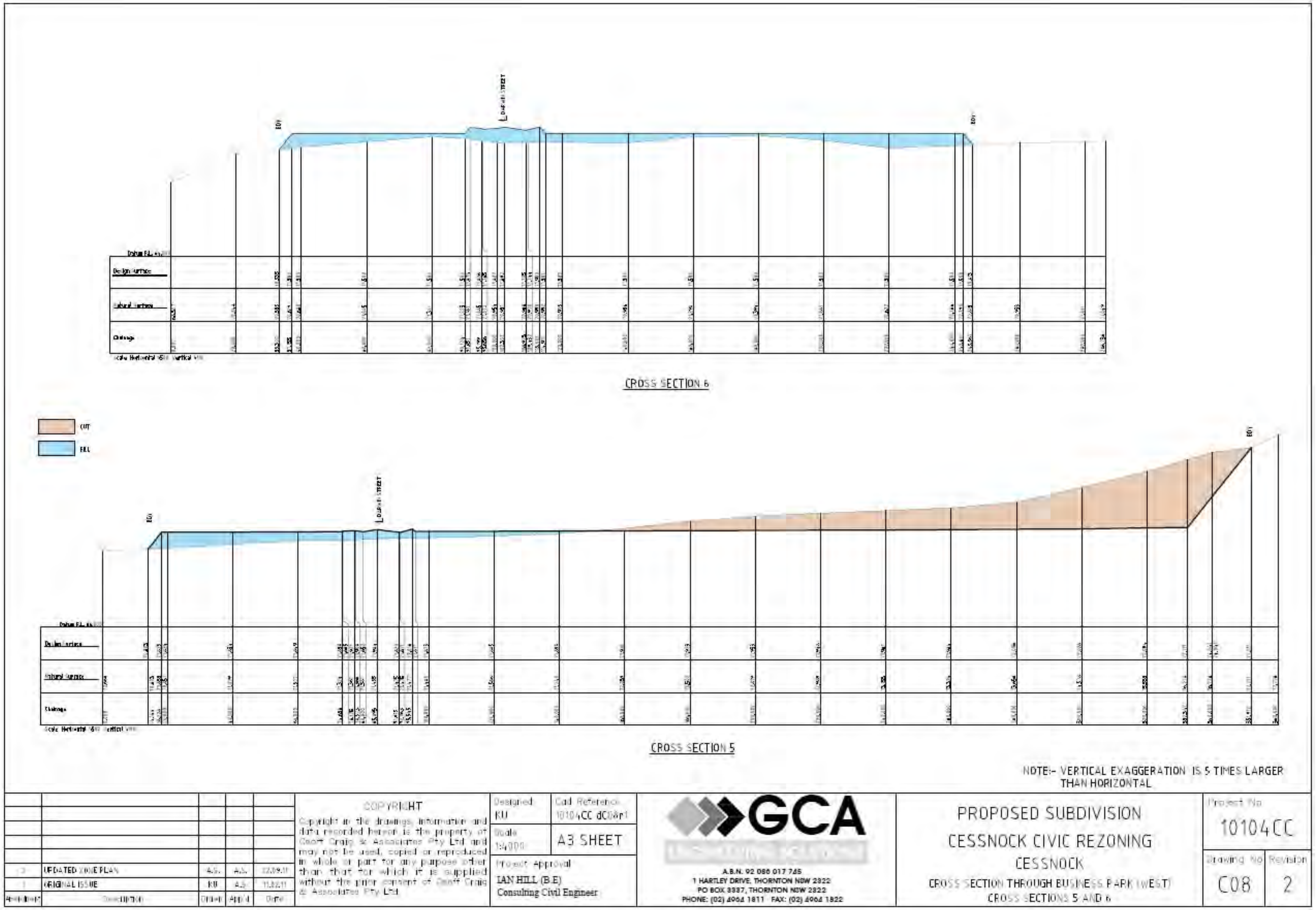
PROPOSED SUBDIVISION
CESSNOCK CIVIC REZONING
CESSNOCK
CROSS SECTION THROUGH LAND WITH RESIDENTIAL POTENTIAL
CROSS SECTION 3 AND 4
Project No 10104CC
Drawing No C07
Revision 2


CROSS SECTION 6
CUT
FILL
CROSS SECTION 5
NOTE:- VERTICAL EXAGGERATION IS 5 TIMES LARGER THAN HORIZONTAL
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Designed KU
Cad Reference 10104CC dC08r1
Scale 1:4000
A3 SHEET
Project Approval
IAN HILL (B.E)
Consulting Civil Engineer
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PROPOSED SUBDIVISION
CESSNOCK CIVIC REZONING
CESSNOCK
CROSS SECTION THROUGH BUSINESS PARK (WEST)
CROSS SECTIONS 5 AND 6
Project No 10104CC
Drawing No C08
Revision 2
UPDATED ZONE PLAN
ORIGINAL ISSUE

Appendix C

HEC-RAS Model Output

Cessnock Civic
Flood Study for Rezoning
Appendix C - Detailed HECRAS Output
J/N 10104 17-Feb-11

DETAILED MODEL OUTPUT - EXISTING CONDITIONS - 1% AEP

Cross Section	Profile	Q Total (m^3/s)	Flood Level (m AHD)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl	Average Section Vel (m/s)
1-1496.32	1% AEP	62.3	73.95	72.88	73.99	0.001091	1.07	95	309	0.23	0.66
1-1438.08	1% AEP	62.3	73.84	73.12	73.91	0.001962	1.53	77	327	0.31	0.81
1-1352.06	1% AEP	62.3	73.75	72.84	73.78	0.001044	1.00	100	390	0.23	0.62
1-1295.67	1% AEP	62.3	73.71	72.40	73.74	0.000626	0.84	102	356	0.18	0.61
1-1241.67	1% AEP	62.3	73.68	72.26	73.70	0.000533	0.72	115	289	0.16	0.54
1-1185.20	1% AEP	62.3	73.65	72.34	73.67	0.000540	0.70	114	174	0.16	0.55
1-1141.55	1% AEP	62.3	73.64	72.25	73.65	0.000345	0.61	141	187	0.13	0.44
1-1092.16	1% AEP	62.3	73.48	72.20	73.59	0.002301	1.45	45	127	0.33	1.37
1-1050.32	1% AEP	62.3	73.26	72.27	73.45	0.004264	1.90	33	17	0.44	1.90
1-1003.46	1% AEP	62.3	73.17	71.93	73.28	0.002362	1.45	43	23	0.33	1.45
1-946.70	1% AEP	62.3	72.95	72.14	73.10	0.004223	1.71	37	24	0.44	1.71
1-923.98	1% AEP	62.3	72.89	71.80	73.00	0.002586	1.44	48	59	0.35	1.31
1-899.04	1% AEP	62.3	72.84	71.74	72.92	0.002493	1.24	50	38	0.33	1.23
1-868.37	1% AEP	62.3	72.66	71.68	72.82	0.004006	1.76	36	30	0.43	1.75
1-808.84	1% AEP	62.3	72.48	71.58	72.58	0.004277	1.39	50	79	0.42	1.24
1-755.90	1% AEP	62.3	72.37	71.24	72.43	0.001746	1.16	83	142	0.29	0.75
1-697.06	1% AEP	62.3	72.24	71.32	72.31	0.002130	1.38	70	111	0.32	0.90
1-619.85	1% AEP	84.8	71.85	71.25	71.92	0.002432	1.32	100	140	0.34	0.85
1-552.35	1% AEP	84.8	71.67	71.24	71.73	0.002715	1.43	107	183	0.36	0.79
1-464.90	1% AEP	84.8	71.54	70.94	71.56	0.000996	0.88	187	232	0.22	0.45
1-389.35	1% AEP	84.8	71.50	70.05	71.51	0.000332	0.59	283	363	0.13	0.30
1-324.06	1% AEP	84.8	71.48	69.49	71.49	0.000166	0.45	314	354	0.09	0.27
1-286.86	1% AEP	84.8	71.47	69.66	71.48	0.000204	0.49	301	366	0.10	0.28
1-237.95	1% AEP	84.8	71.47	69.12	71.47	0.000071	0.32	411	423	0.06	0.21
1-207.91	1% AEP	84.8	71.47	69.19	71.47	0.000058	0.27	444	434	0.06	0.19
1-174.92	1% AEP	84.8	71.47	69.12	71.47	0.000052	0.27	393	377	0.05	0.22
1-134.12	1% AEP	84.8	71.46	69.04	71.47	0.000039	0.24	394	285	0.05	0.22
1-112.22	1% AEP	84.8	71.46	69.11	71.47	0.000049	0.27	351	286	0.05	0.24
1-82.90	1% AEP	84.8	71.46	69.20	71.46	0.000057	0.27	358	288	0.06	0.24
1-35.51	1% AEP	84.8	71.45	69.93	71.46	0.000270	0.45	329	462	0.11	0.26
2-438.76	1% AEP	24.1	73.84	73.66	73.90	0.010028	1.09	22	54	0.55	1.09
2-400.39	1% AEP	24.1	73.51	73.34	73.57	0.008593	1.03	23	57	0.51	1.03
2-362.46	1% AEP	24.1	73.24	72.90	73.29	0.006216	1.02	24	46	0.45	1.02
2-327.79	1% AEP	24.1	73.02	72.75	73.08	0.006204	1.06	23	43	0.45	1.06
2-299.56	1% AEP	24.1	72.81	72.52	72.88	0.007177	1.15	21	37	0.49	1.15
2-263.45	1% AEP	24.1	72.51	72.20	72.61	0.009512	1.44	17	26	0.57	1.44
2-229.81	1% AEP	24.1	72.39	71.71	72.42	0.001929	0.76	32	40	0.27	0.76
2-203.97	1% AEP	24.1	72.34	71.80	72.37	0.002062	0.72	33	47	0.27	0.72
2-168.35	1% AEP	24.1	72.30	71.54	72.31	0.000829	0.50	49	61	0.18	0.50
2-129.00	1% AEP	24.1	72.27	71.44	72.28	0.000837	0.46	53	75	0.17	0.46
2-97.23	1% AEP	24.1	72.24	71.41	72.25	0.000961	0.49	49	68	0.19	0.49

Cessnock Civic
Flood Study for Rezoning
Appendix C - Detailed HECRAS Output
J/N 10104 17-Feb-11

DETAILED MODEL OUTPUT - DEVELOPED CONDITIONS - 1% AEP

Cross Section	Profile	Q Total (m^3/s)	Flood Level (m AHD)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl	Average Section Vel (m/s)
1-1497.57	1% AEP	62.3	73.92	72.62	73.97	0.000952	1.10	103	329	0.22	0.60
1-1438.5	1% AEP	62.3	73.82	73.08	73.88	0.001995	1.42	74	344	0.30	0.84
1-1351.82	1% AEP	62.3	73.70	72.86	73.74	0.001175	1.09	98	418	0.24	0.64
1-1294.32	1% AEP	62.3	73.66	72.36	73.68	0.000603	0.82	107	384	0.18	0.58
1-1242.88	1% AEP	62.3	73.62	72.17	73.65	0.000588	0.79	98	308	0.17	0.63
1-1185.49	1% AEP	62.3	73.57	72.27	73.61	0.000912	0.93	76	191	0.21	0.82
1-1140.33	1% AEP	62.3	73.53	72.20	73.57	0.000926	0.88	79	200	0.21	0.79
1-1093.40	1% AEP	62.3	73.40	72.08	73.49	0.002398	1.31	48	132	0.33	1.29
1-1050.36	1% AEP	62.3	73.18	72.17	73.35	0.003985	1.81	34	19	0.42	1.81
1-1003.54	1% AEP	62.3	73.10	71.84	73.19	0.002047	1.33	47	25	0.31	1.33
1-945.89	1% AEP	62.3	72.89	72.09	73.02	0.004014	1.61	39	26	0.42	1.61
1-923.73	1% AEP	62.3	72.84	71.72	72.93	0.002163	1.32	50	62	0.32	1.24
1-899.59	1% AEP	62.3	72.77	71.75	72.86	0.002478	1.37	52	37	0.34	1.20
1-869.63	1% AEP	62.3	72.58	71.62	72.73	0.004010	1.73	36	21	0.42	1.73
1-810.54	1% AEP	62.3	72.34	71.50	72.49	0.003880	1.79	43	66	0.42	1.46
1-756.22	1% AEP	62.3	72.22	71.18	72.30	0.002061	1.34	64	103	0.31	0.97
1-697.10	1% AEP	62.3	72.02	71.27	72.15	0.003327	1.67	52	64	0.40	1.21
1-619.49	1% AEP	84.8	72.04	71.15	72.10	0.001678	1.14	91	80	0.28	0.93
1-552.52	1% AEP	84.8	71.84	71.22	71.94	0.003011	1.73	78	60	0.39	1.09
1-464.16	1% AEP	84.8	71.57	70.98	71.67	0.002847	1.65	90	97	0.37	0.94
1-387.71	1% AEP	84.8	71.50	69.97	71.54	0.000679	0.92	137	117	0.19	0.62
1-323.63	1% AEP	84.8	71.49	69.45	71.50	0.000212	0.54	197	134	0.11	0.43
1-287.17	1% AEP	84.8	71.48	69.60	71.49	0.000277	0.61	180	120	0.12	0.47
1-239.58	1% AEP	84.8	71.48	69.09	71.48	0.000077	0.33	275	124	0.07	0.31
1-207.74	1% AEP	84.8	71.48	69.16	71.48	0.000062	0.29	297	126	0.06	0.29
1-174.50	1% AEP	84.8	71.48	69.09	71.48	0.000047	0.26	338	146	0.05	0.25
1-134.13	1% AEP	84.8	71.47	69.02	71.48	0.000032	0.22	417	202	0.04	0.20
1-110.80	1% AEP	84.8	71.47	69.09	71.48	0.000043	0.24	366	212	0.05	0.23
1-81.15	1% AEP	84.8	71.47	69.16	71.47	0.000041	0.24	377	239	0.05	0.23
1-35.11	1% AEP	84.8	71.45	69.83	71.47	0.000431	0.66	223	333	0.15	0.38
2-468.29	1% AEP	24.1	73.89	73.38	73.90	0.001518	0.57	53	102	0.23	0.45
2-452.16	1% AEP	24.1	73.80	73.43	73.85	0.004241	0.98	28	118	0.39	0.87
2-423.01	1% AEP	24.1	73.65	73.34	73.71	0.004970	1.12	22	69	0.42	1.08
2-413.01	1% AEP	24.1	73.57	73.31	73.65	0.007411	1.27	19	30	0.51	1.27
2-391.74	1% AEP	24.1	73.41	73.14	73.49	0.006851	1.23	20	30	0.49	1.23
2-357.03	1% AEP	24.1	73.21	72.89	73.27	0.005438	1.10	22	34	0.44	1.10
2-337.81	1% AEP	24.1	73.09	72.77	73.16	0.005808	1.19	20	29	0.45	1.19
2-307.33	1% AEP	24.1	72.96	72.53	73.01	0.003568	1.00	24	31	0.36	1.00
2-272.62	1% AEP	24.1	72.87	72.30	72.91	0.002159	0.84	29	33	0.29	0.84
2-240.72	1% AEP	24.1	72.82	72.12	72.84	0.001558	0.75	32	34	0.25	0.75
2-235.00	1% AEP	24.1					*8 x 1800mm (dia) culverts*				
2-222.34	1% AEP	24.1	72.28	71.92	72.35	0.005098	1.20	20	26	0.43	1.20
2-206.06	1% AEP	24.1	72.22	71.79	72.27	0.003361	0.94	26	35	0.35	0.94
2-187.63	1% AEP	24.1	72.17	71.67	72.21	0.002688	0.86	28	36	0.31	0.86
2-159.28	1% AEP	24.1	72.13	71.46	72.15	0.001328	0.64	38	46	0.22	0.64
2-137.27	1% AEP	24.1	72.11	71.26	72.12	0.000651	0.48	50	55	0.16	0.48
2-122.27	1% AEP	24.1	72.11	71.14	72.11	0.000289	0.35	74	86	0.11	0.33
2-72.57	1% AEP	24.1	72.10	70.82	72.10	0.000184	0.31	79	68	0.09	0.31

Cessnock Civic
Flood Study for Rezoning
Appendix C - Detailed HECRAS Output
J/N 10104 17-Feb-11

DETAILED MODEL OUTPUT - DEVELOPED CONDITIONS - PMF

Cross Section	Profile	Q Total (m^3/s)	Flood Level (m AHD)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl	Average Section Vel (m/s)
1-1496.32	PMF	471.0	76.14	74.36	76.15	0.000213	0.77	1379	586	0.12	0.34
1-1438.08	PMF	471.0	76.13	73.22	76.13	0.000200	0.72	1420	589	0.11	0.33
1-1352.06	PMF	471.0	76.11	73.93	76.12	0.000183	0.72	1452	592	0.11	0.32
1-1295.67	PMF	471.0	76.10	73.52	76.11	0.000137	0.64	1567	597	0.10	0.30
1-1241.67	PMF	471.0	76.09	73.47	76.10	0.000152	0.67	1589	688	0.10	0.30
1-1185.20	PMF	471.0	76.06	73.38	76.08	0.000418	1.12	904	402	0.17	0.52
1-1141.55	PMF	471.0	76.04	73.38	76.06	0.000392	1.08	887	366	0.16	0.53
1-1092.16	PMF	471.0	76.02	73.37	76.04	0.000494	1.13	827	361	0.17	0.57
1-1050.32	PMF	471.0	75.87	75.04	75.99	0.002009	2.24	504	342	0.35	0.93
1-1003.46	PMF	471.0	75.56	75.09	75.86	0.003663	2.91	344	325	0.47	1.37
1-959.53	PMF	471.0	74.95	74.95	75.54	0.008608	4.01	224	214	0.70	2.10
1-868.37	PMF	502.8	74.14	73.96	74.47	0.007404	3.55	306	261	0.64	1.64
1-808.84	PMF	502.8	73.91	73.41	74.02	0.003058	2.31	493	345	0.42	1.02
1-755.90	PMF	502.8	73.81	73.10	73.87	0.001831	1.85	602	380	0.33	0.84
1-697.06	PMF	502.8	73.70	72.94	73.76	0.001845	1.88	597	361	0.33	0.84
1-619.85	PMF	616.0	73.55	72.71	73.62	0.001745	1.61	670	433	0.31	0.92
1-552.35	PMF	616.0	73.43	72.62	73.50	0.001716	1.62	691	438	0.31	0.89
1-464.90	PMF	616.0	73.30	72.39	73.36	0.001435	1.63	777	451	0.29	0.79
1-389.35	PMF	616.0	73.19	72.20	73.25	0.001197	1.66	787	432	0.27	0.78
1-324.06	PMF	616.0	73.14	71.48	73.18	0.000685	1.34	915	473	0.21	0.67
1-286.86	PMF	616.0	73.10	71.49	73.15	0.000879	1.40	825	459	0.23	0.75
1-237.95	PMF	616.0	73.07	70.65	73.12	0.000490	1.15	954	497	0.18	0.65
1-207.91	PMF	616.0	73.06	70.46	73.10	0.000391	1.01	1044	539	0.16	0.59
1-174.92	PMF	616.0	73.06	70.31	73.09	0.000319	0.88	1108	574	0.14	0.56
1-134.12	PMF	616.0	73.04	70.09	73.07	0.000273	0.86	1157	585	0.13	0.53
1-112.22	PMF	616.0	73.03	70.18	73.07	0.000316	0.92	1109	605	0.14	0.56
1-82.90	PMF	616.0	73.02	70.31	73.05	0.000355	0.97	1050	607	0.15	0.59
1-35.51	PMF	616.0	73.00	71.51	73.02	0.000584	1.09	1228	689	0.19	0.50
2-492.27	PMF	136.1	75.37	74.44	75.41	0.002200	1.09	156	109	0.31	0.87
2-479.37	PMF	136.1	75.35	74.19	75.38	0.001484	1.05	185	125	0.26	0.74
2-464.80	PMF	136.1	75.33	74.02	75.36	0.000773	0.92	212	127	0.20	0.64
2-448.21	PMF	136.1	75.31	74.21	75.35	0.000960	1.01	200	134	0.22	0.68
2-420.78	PMF	122.1	75.31	74.23	75.35	0.001161	0.86	141	97	0.23	0.86
2-400.85	PMF	122.1	75.28	74.17	75.32	0.001157	1.13	154	101	0.24	0.79
2-361.88	PMF	122.1	75.25	73.90	75.29	0.000696	1.02	189	112	0.20	0.65
2-338.19	PMF	122.1	75.22	73.69	75.27	0.000789	1.09	176	123	0.21	0.70
2-311.37	PMF	122.1	75.19	73.49	75.24	0.000811	1.08	153	112	0.21	0.80
2-281.07	PMF	122.1	75.17	73.25	75.22	0.000682	1.02	150	111	0.20	0.81
2-256.98	PMF	122.1	75.16	73.09	75.20	0.000601	0.97	149	110	0.18	0.82
2-236.00	PMF	122.1					*6 x 1800mm (dia) culverts*				
2-223.62	PMF	122.1	73.78	72.95	74.01	0.006470	2.11	58	40	0.54	2.11
2-202.49	PMF	122.1	73.79	72.66	73.89	0.002374	1.39	88	52	0.34	1.39
2-168.51	PMF	122.1	73.76	72.34	73.81	0.001213	1.00	124	95	0.24	0.98
2-133.99	PMF	122.1	73.75	72.00	73.78	0.000486	0.73	183	90	0.16	0.67
2-97.20	PMF	122.1	73.73	71.84	73.76	0.000543	0.80	162	77	0.17	0.76
3-429.63	PMF	31.8	75.35	74.17	75.35	0.000264	0.25	126	87	0.07	0.25
3-423.42	PMF	31.8	75.35	74.17	75.35	0.000224	0.23	137	96	0.06	0.23
3-416.00	PMF	31.8	75.35	74.18	75.35	0.000240	0.25	133	94	0.07	0.24
3-407.41	PMF	31.8	75.34	74.16	75.35	0.000209	0.24	141	99	0.06	0.23
3-396.68	PMF	31.8	75.34	74.01	75.35	0.000177	0.24	150	102	0.06	0.21
3-374.72	PMF	31.8	75.34	73.47	75.34	0.000099	0.21	183	111	0.05	0.17
3-355.28	PMF	31.8	75.34	72.62	75.34	0.000030	0.15	297	160	0.03	0.11
3-336.70	PMF	31.8	75.34	72.69	75.34	0.000036	0.16	283	160	0.03	0.11
3-312.86	PMF	31.8	75.34	72.35	75.34	0.000036	0.14	264	132	0.03	0.12
3-271.75	PMF	31.8	75.34	72.48	75.34	0.000056	0.08	232	135	0.03	0.14
3-219.04	PMF	31.8	75.33	73.72	75.33	0.000255	0.21	148	133	0.06	0.21
3-177.89	PMF	31.8	75.31	74.48	75.31	0.000806	0.41	111	170	0.12	0.29
3-136.27	PMF	31.8	75.19	74.78	75.22	0.003875	0.91	55	110	0.25	0.58
3-98.17	PMF	31.8	75.11	74.50	75.12	0.001157	0.55	83	106	0.14	0.38

Appendix C - HECRAS Results (E.xlsx 17/02/2011 8:10 PM

Cessnock Civic
Flood Study for Rezoning
Appendix C - Detailed HECRAS Output
J/N 10104 17-Feb-11

DETAILED MODEL OUTPUT - DEVELOPED CONDITIONS - PMF

Cross Section	Profile	Q Total (m^3/s)	Flood Level (m AHD)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl	Average Section Vel (m/s)
1-1496.32	PMF	471.0	76.14	74.36	76.15	0.000213	0.77	1379	586	0.12	0.34
1-1438.08	PMF	471.0	76.13	73.22	76.13	0.000200	0.72	1420	589	0.11	0.33
1-1352.06	PMF	471.0	76.11	73.93	76.12	0.000183	0.72	1452	592	0.11	0.32
1-1295.67	PMF	471.0	76.10	73.52	76.11	0.000137	0.64	1567	597	0.10	0.30
1-1241.67	PMF	471.0	76.09	73.47	76.10	0.000152	0.67	1589	688	0.10	0.30
1-1185.20	PMF	471.0	76.06	73.38	76.08	0.000418	1.12	904	402	0.17	0.52
1-1141.55	PMF	471.0	76.04	73.38	76.06	0.000392	1.08	887	366	0.16	0.53
1-1092.16	PMF	471.0	76.02	73.37	76.04	0.000494	1.13	827	361	0.17	0.57
1-1050.32	PMF	471.0	75.87	75.04	75.99	0.002009	2.24	504	342	0.35	0.93
1-1003.46	PMF	471.0	75.56	75.09	75.85	0.003663	2.91	344	325	0.47	1.37
1-959.53	PMF	471.0	74.95	74.95	75.54	0.008608	4.01	224	214	0.70	2.10
1-868.37	PMF	502.8	74.14	73.96	74.47	0.007404	3.55	306	261	0.64	1.64
1-808.84	PMF	502.8	73.91	73.41	74.02	0.003058	2.31	493	345	0.42	1.02
1-755.90	PMF	502.8	73.81	73.10	73.87	0.001831	1.85	602	380	0.33	0.84
1-697.06	PMF	502.8	73.70	72.94	73.76	0.001845	1.88	597	361	0.33	0.84
1-619.85	PMF	616.0	73.55	72.71	73.62	0.001745	1.61	670	433	0.31	0.92
1-552.35	PMF	616.0	73.43	72.62	73.50	0.001716	1.62	691	438	0.31	0.89
1-464.90	PMF	616.0	73.30	72.39	73.36	0.001435	1.63	777	451	0.29	0.79
1-389.35	PMF	616.0	73.19	72.20	73.25	0.001197	1.66	787	432	0.27	0.78
1-324.06	PMF	616.0	73.14	71.48	73.18	0.000685	1.34	915	473	0.21	0.67
1-286.86	PMF	616.0	73.10	71.49	73.15	0.000879	1.40	825	459	0.23	0.75
1-237.95	PMF	616.0	73.07	70.65	73.12	0.000490	1.15	954	497	0.18	0.65
1-207.91	PMF	616.0	73.06	70.46	73.10	0.000391	1.01	1044	539	0.16	0.59
1-174.92	PMF	616.0	73.06	70.31	73.09	0.000319	0.88	1108	574	0.14	0.56
1-134.12	PMF	616.0	73.04	70.09	73.07	0.000273	0.86	1157	585	0.13	0.53
1-112.22	PMF	616.0	73.03	70.18	73.07	0.000316	0.92	1109	605	0.14	0.56
1-82.90	PMF	616.0	73.02	70.31	73.05	0.000355	0.97	1050	607	0.15	0.59
1-35.51	PMF	616.0	73.00	71.51	73.02	0.000584	1.09	1228	689	0.19	0.50
2-492.27	PMF	136.1	75.37	74.44	75.41	0.002200	1.09	156	109	0.31	0.87
2-479.37	PMF	136.1	75.35	74.19	75.38	0.001484	1.05	185	125	0.26	0.74
2-464.80	PMF	136.1	75.33	74.02	75.36	0.000773	0.92	212	127	0.20	0.64
2-448.21	PMF	136.1	75.31	74.21	75.35	0.000960	1.01	200	134	0.22	0.68
2-420.78	PMF	122.1	75.31	74.23	75.35	0.001161	0.86	141	97	0.23	0.86
2-400.85	PMF	122.1	75.28	74.17	75.32	0.001157	1.13	154	101	0.24	0.79
2-361.88	PMF	122.1	75.25	73.90	75.29	0.000696	1.02	189	112	0.20	0.65
2-338.19	PMF	122.1	75.22	73.69	75.27	0.000789	1.09	176	123	0.21	0.70
2-311.37	PMF	122.1	75.19	73.49	75.24	0.000811	1.08	153	112	0.21	0.80
2-281.07	PMF	122.1	75.17	73.25	75.22	0.000682	1.02	150	111	0.20	0.81
2-256.98	PMF	122.1	75.16	73.09	75.20	0.000601	0.97	149	110	0.18	0.82
2-236.00	PMF	122.1					*6 x 1800mm (dia) culverts*				
2-223.62	PMF	122.1	73.78	72.95	74.01	0.006470	2.11	58	40	0.54	2.11
2-202.49	PMF	122.1	73.79	72.66	73.89	0.002374	1.39	88	52	0.34	1.39
2-168.51	PMF	122.1	73.76	72.34	73.81	0.001213	1.00	124	95	0.24	0.98
2-133.99	PMF	122.1	73.75	72.00	73.78	0.000486	0.73	183	90	0.16	0.67
2-97.20	PMF	122.1	73.73	71.84	73.76	0.000543	0.80	162	77	0.17	0.76
3-429.63	PMF	31.8	75.35	74.17	75.35	0.000264	0.25	126	87	0.07	0.25
3-423.42	PMF	31.8	75.35	74.17	75.35	0.000224	0.23	137	96	0.06	0.23
3-416.00	PMF	31.8	75.35	74.18	75.35	0.000240	0.25	133	94	0.07	0.24
3-407.41	PMF	31.8	75.34	74.16	75.35	0.000209	0.24	141	99	0.06	0.23
3-396.68	PMF	31.8	75.34	74.01	75.35	0.000177	0.24	150	102	0.06	0.21
3-374.72	PMF	31.8	75.34	73.47	75.34	0.000099	0.21	183	111	0.05	0.17
3-355.28	PMF	31.8	75.34	72.62	75.34	0.000030	0.15	297	160	0.03	0.11
3-336.70	PMF	31.8	75.34	72.69	75.34	0.000036	0.16	283	160	0.03	0.11
3-312.86	PMF	31.8	75.34	72.35	75.34	0.000036	0.14	264	132	0.03	0.12
3-271.75	PMF	31.8	75.34	72.48	75.34	0.000056	0.08	232	135	0.03	0.14
3-219.04	PMF	31.8	75.33	73.72	75.33	0.000255	0.21	148	133	0.06	0.21
3-177.89	PMF	31.8	75.31	74.48	75.31	0.000806	0.41	111	170	0.12	0.29
3-136.27	PMF	31.8	75.19	74.78	75.22	0.003875	0.91	55	110	0.25	0.58
3-98.17	PMF	31.8	75.11	74.50	75.12	0.001157	0.55	83	106	0.14	0.38

Appendix C - HECRAS Results.xls 17/02/2011

Appendix D

Study Limitations

Cessnock Civic
Flood Study for Rezoning
Study limitations

1. General

This report has been prepared in accordance with the scope of work/services set out in the contract, or as otherwise agreed, between Geoff Craig & Associates (GCA) and the Client.

In preparing this report, GCA has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report. Except as otherwise stated in the report, GCA has not verified the accuracy or completeness of the data.

To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this report are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. GCA will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to GCA.

This report has been prepared for the exclusive benefit of the Client and no other party. GCA assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with in this report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in this report (including without limitation matters arising from any negligent act or omission of GCA or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in this report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

2. Specific

The study has been prepared for the Rezoning of the Cessnock Civic site.

Modelling and analysis undertaken has an appropriate level of detail for a rezoning. Further analysis will be required for the final landform proposal as part of the Subdivision Development Application.

The study has been prepared in accordance with normal practice current at the time of the flood analysis. GCA shall not be liable to update this study to reflect changes in normal industry practice.

GCA shall not be liable for adverse impacts as a result of designs undertaken by others, where GCA has not had the opportunity to undertake further modelling and confirm that the intended outcomes can be met by those designs.

To the best of GCA's knowledge, the facts and matters described in this report reasonably represent the conditions at the time of printing of the report. However, the passage of time, the manifestation of latent conditions or the impact of future events (including a change in applicable law) may have resulted in a variation to the conditions.

GCA will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Annexure B

MSB Correspondence 25 March 2010

MINE SUBSIDENCE BOARD

25 March 2010

The General Manager
Cessnock City Council
P O Box 152
Cessnock NSW 2325

Attention: Mr Bernie Mortomore

Dear Mr Mortomore,

RE: Proposed Industrial Rezoning and Subdivision
Lots 18 & 19 (Sec D) DP 4653, Lot 23 DP 845986 and Lot 1 DP 1036300 271 Vincent St Cessnock

I refer to a meeting with Cessnock Council's Major Projects Co-Coordinator, Ms Julie Wells, on the 17 March 2010 and the Mine Subsidence Board's advice dated 25 October 2005 to Cessnock City Council under s.62 of the Environmental Planning and Assessment Act 1979 for the proposed rezoning of Lot 23 DP 845986 and Lot 1 DP 1036300 Vincent St Cessnock. The site is not in a Mine Subsidence District.

Since a major flooding event on 10 June 2007 there have been ongoing discussions between Regional Land and the Board. Regional Land subsequently arranged for Parsons Brinkerhoff to undertake a detailed geotechnical assessment of a large portion of the site. This information has been reviewed by the Mine Subsidence Board's geotechnical consultant Coffey Geotechnics.

The Mine Subsidence Board would have no objection to development of the following portions of the site as identified in the attached Parsons Brinkerhoff Plan titled "Development Boundaries" Figure 11 – Revision C.

- Zone A(1) – Pothole design requirements apply
- Zone A(3) - hardstand only
- Zone E(1) – fill to be engineered so there is no damage to structures
- Zone F – drifts are to be excavated and backfilled with controlled fill. No structures to be build over the drift area.
- Zone G – no recorded mine workings. Mine Subsidence Board also provided advice to Cessnock Council in correspondence dated 14 December 2009

Zones A(2) and E(2) are buffer zones against areas that have not been subject to geotechnical assessment,

- Zone A(2) – Buffer zone immediately surrounding Zone A(3) and Zone A(1) which can be developed with foundations established to the floor of the seam.
- Zone E (2) – Buffer zone which can be developed with foundations established below the base of the seam, with the exception of the area south of Black Creek, adjacent to Zone H, where no development is to occur at this time.

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Although the Board's approval is not required for subdivision and surface development, we would be pleased to provide advice to Council.

The remainder of the site includes areas of shallow mined workings where there is a risk of unplanned subsidence potholes, cracking or surface depressions and no development is supported at this time. We strongly recommend the applicant be required to develop and maintain a long term Management Plan to deal with the risks associated with such events.

Yours faithfully

Greg Cole-Clark
Chief Executive Officer

Cc – A/District Manager - Singleton
- Managing Director Regional Land

Annexure C

GCA Plan of Management for Mine Subsidence
22 September 2011

Cessnock Civic, Vincent Street, Cessnock

Plan of Management for Mine Subsidence

Vincent Street Holdings Pty Ltd

FINAL
Revision: 5
Version Date: 22 September 2011

GCA ENGINEERING SOLUTIONS

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10104C Plan of Management for Mine Subsidence Rev 5

Revision	Description	Author		Review		Approved	
1	Draft Issue to Client	IH	12.1.11	AS	14.1.11	IH	14.1.11
2	Draft Issue for MSB Consultation	IH	14.1.11	AS	14.1.11	IH	14.1.11
3	Final Issue	AS	16.06.11	AS	16.06.11	IH	16.06.11
4	Updated Figure 3	AS	12.09.11	AS	12.09.11	IH	12.09.11
5	For updated zone plan	AS	22.09.11	AS	22.09.11	IH	22.09.11

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Appendices

List of Acronyms

CCC	Cessnock City Council
GCA	GCA Engineering Solutions
MSB	NSW Government Mine Subsidence Board

Definitions

'Plan' means this Plan of Management for Mine Subsidence, Cessnock Civic, Cessnock.

'Site' means the area of land within the Cessnock Civic Development described in Section 2.1 of this Plan.

1. Introduction

1.1 Overview

This report has been produced following a request from the NSW Mine Subsidence Board (MSB) in a letter to Cessnock City Council (CCC) dated 25 November 2010 for the applicant (Vincent Street Holdings Pty Ltd) to develop and maintain a long term Management Plan to deal with risks associated with mine subsidence in areas of the Cessnock Civic Development site which are not yet approved by the MSB for development. The location of the Cessnock Civic Development is shown on Figure 1.

GCA Engineering Solutions (GCA) was subsequently engaged by Vincent Street Holdings Pty Ltd to prepare a Plan of Management for Mine Subsidence (the Plan). The Plan establishes the risk management approach for residual land (the Site) within the Cessnock Civic Development that has not yet been confirmed by the MSB as being suitable for development. This plan applies only to the residual land within the Cessnock Civic Development, with extents described in Section 2.

Figure 1 **Locality plan**
(Image obtained from Google Maps)

1.2 Intention

The intent of the Plan is to provide a set of guidelines that cover:

- the land area to which the Plan applies (the Site)
- who is responsible
- access restrictions
- long term monitoring
- procedures to make the site safe in the event of subsidence.

1.3 Objectives

The objectives of the Plan are to ensure:

- that access to the Site by the public is restricted
- that all operations on site and conducted safely
- that long term monitoring of the Site surface conditions is routinely completed.

2. Land to which the Plan applies (the Site)

2.1 The Site

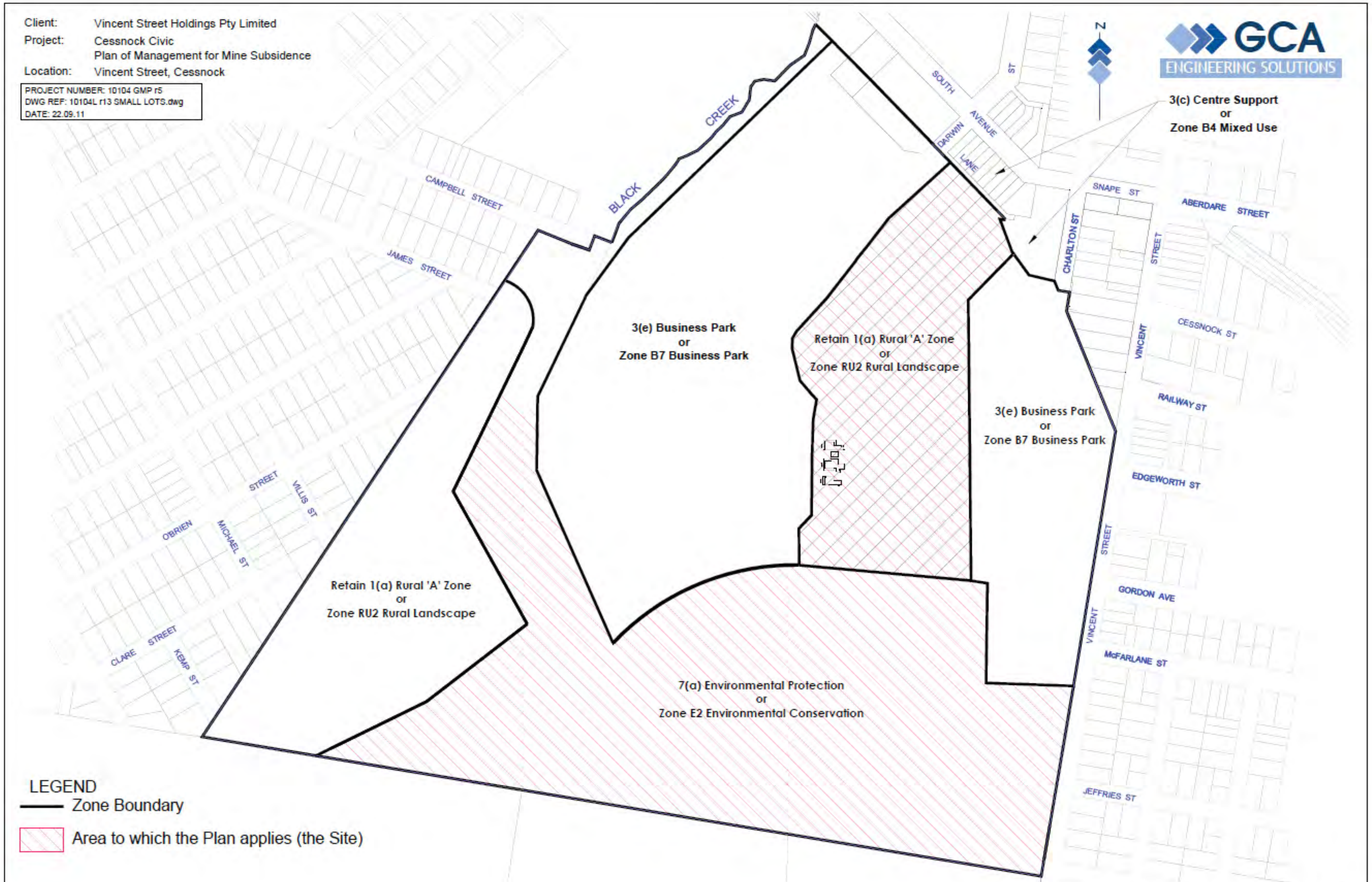
The areas forming the Site and to which the Plan applies comprise:

- part of the area which will be retained as Rural 'A' Zone or Zone RU2 Rural Landscape (Draft LEP 2009)
- the area noted as 7(a) Environmental Protection or Zone E2 Environmental Conservation (Draft LEP 2009).

The above areas are identified on Figure 2, over page.

2.2 Responsibilities

It is the land owner's responsibility to ensure that the Site is maintained in accordance with the conditions specified in the Plan, and the underlying principle that every reasonable and practical step that is available should be taken to remove risk to the public.



Are to which the Plan applies (the Site)

Figure 2

3. Policy statement

This section describes the policies that will directly relate to the Site.

The following current policies apply to the Site:

- No development shall be undertaken as documented in the conclusions of the Parsons Brinckerhoff (PB) "Cessnock Civic Centre, Zone A Mine Subsidence Investigation – Interpretive Report " (January 2010).
- Long term ongoing monitoring will be undertaken. This is described further in Sections 4 and 5 of this Plan.
- Repair of any surface subsidence event shall be undertaken to a standard to ensure public safety.

4. Plan of management

Management actions for the site can be generally described in terms of the three main areas outlined below.

4.1 Restriction of public access

It is the responsibility of the land owner to ensure access to the Site by the public is restricted. A man proof fence shall be constructed around the site perimeter to prevent access by the public. Details of the fence locations are provided in Section 5.1.

4.2 Site operations

All operations on the Site shall be conducted in safe manner. The location of access points and safety measures is documented in Section 5.2.

4.3 Long Term monitoring

The surface conditions of the Site shall be routinely inspected. Details of the reporting procedure as well as actions in the event of a subsidence event are documented in Section 5.3.

5. Management actions

5.1 Fencing

A man proof fence shall be constructed around the perimeter of the site to prevent public access. The location of the fence shall be as follows (also refer Figure 3):

- The southern fence boundary shall run along the entire length of the Environmental Protection Zone southern property boundary
- The eastern fence boundary shall run along the eastern side of the Environmental Protection Zone and then around the western perimeter of the Business Park
- The northern fence boundary will run on the southern boundary of the Mixed Use sites with a gated access located at Darwin Street. The fence will then continue around the southern perimeter of the council site and terminate at Black Creek
- The western fence boundary will begin at Black Creek and run south along the western property boundary in line with the existing fences from the residential development.

Additional fencing (referred to as 'deferred fence' on Figure 3) will be provided as the staged development occurs within the B3 Business Park zoned land. Following erection of the 'deferred fencing', fencing between these zones and existing development to the west (for residential) and north (for business park) will be removed.

5.2 Site Access

There will be three locked gated access points to the overall Cessnock Civic Development that will be used to access the Site. These are located:

- off Vincent Street accessing the Environmental Protection Zone
- off the extension of Darwin Street accessing the Business Park
- off Michael Street accessing the land to be retained as 1(a) Rural 'A'.

The existing gravel tracks shall be regularly maintained and vehicle access shall be limited to the existing tracks only. Access to all other areas of the Site shall be on foot.

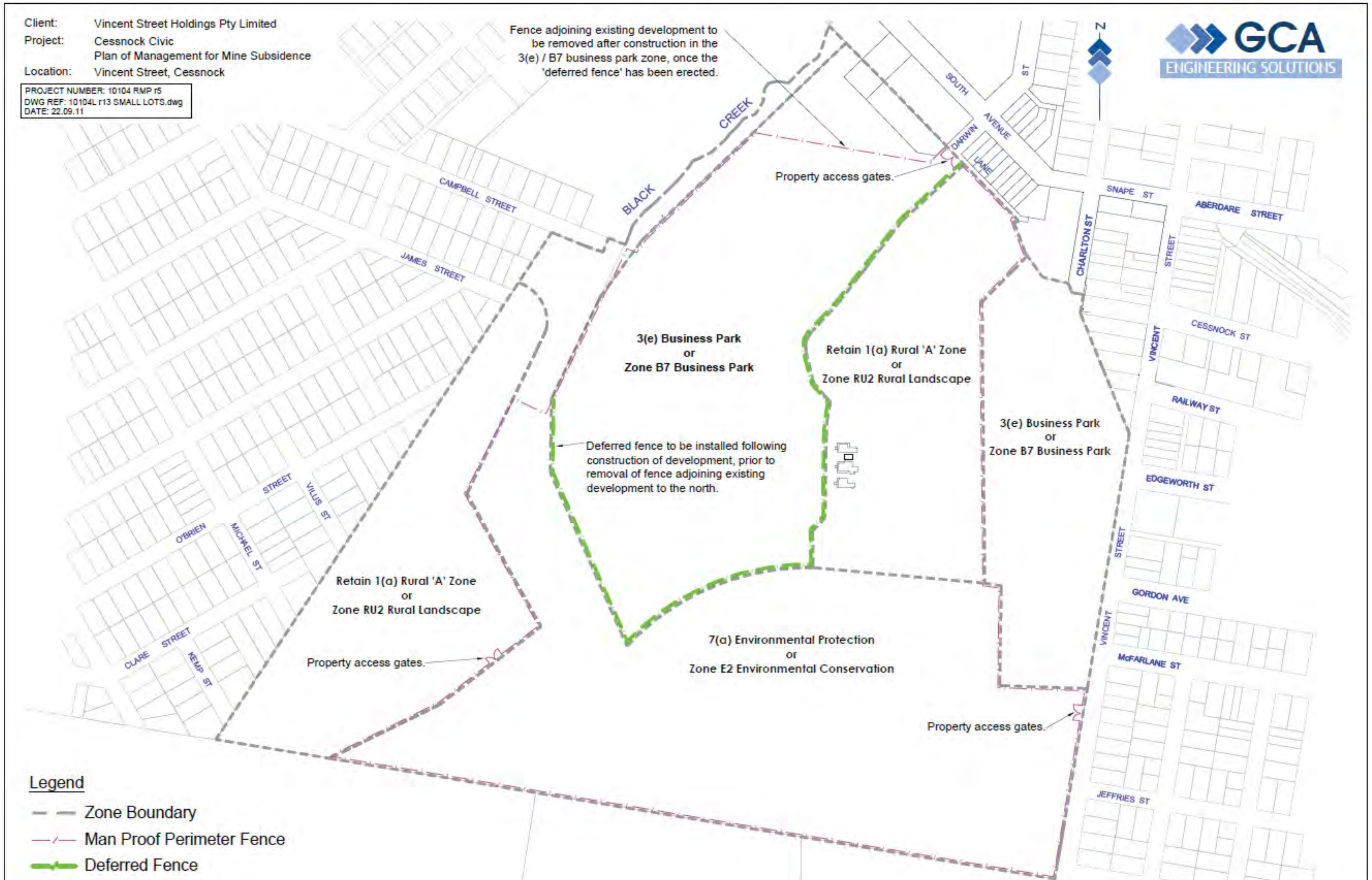
The location of the access points are shown on Figure 3.

5.3 Monitoring of the Site

The surface conditions of the Site shall be inspected every 6 months. Following each inspection a brief report shall be presented by the land owner to CCC within two weeks noting the condition of the Site and any changes that may have occurred.

Appendix A includes a flow chart of the ongoing monitoring process that will be followed. It is noted that if minor surface subsidence is evident then the process is to notify a geotechnical engineer who will inspect the area to determine if further safety measures need to be undertaken.

If a significant event occurs and there is obvious risk to public safety then the location will be immediately fenced to prevent access and the Site subsequently inspected by a geotechnical engineer to assess future actions and remediation. In addition the MSB and CCC shall be formally notified. After the affected area has been remediated, the fence will be removed, and the area shall be allowed to regenerate with native vegetation.



Fence layout and site access locations

Figure 3

5.4 Monitoring of Black Creek

In addition to the regular monitoring events Black Creek should be inspected after major rainfall events to ensure that no surface subsidence has occurred.

5.5 Further investigation permitted

Reference is made to the report by PB titled "Cessnock Civic Centre, Vincent Street Cessnock Mine Hazard Risk Assessment, April 2009" which concludes that the area noted within the Site as Rural Zone on Figure 2 has the potential for future development subject to the results of future detailed geotechnical investigation.

6. References

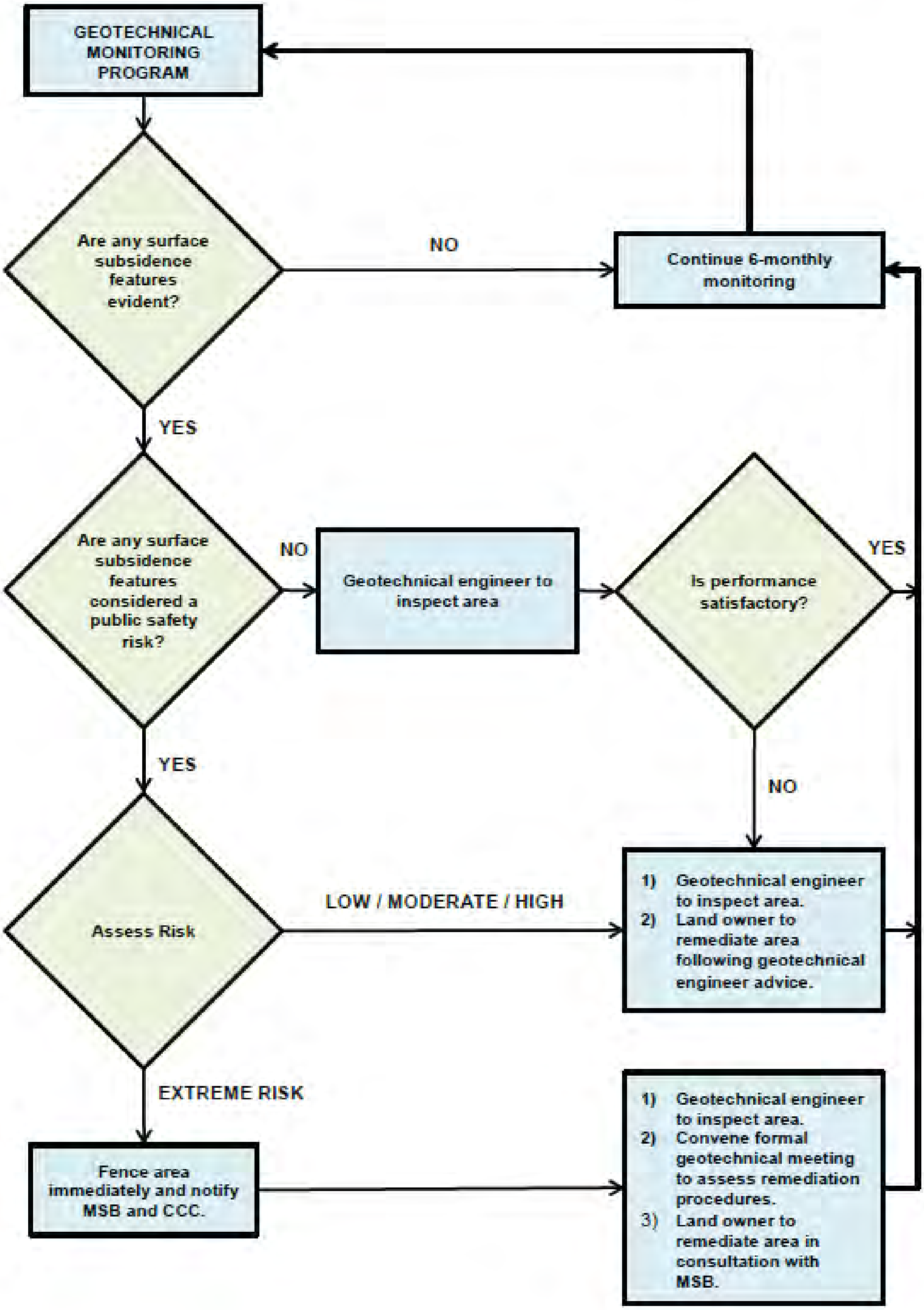
The following documents were referenced in preparing the Plan:

- "Cessnock Civic Centre, Vincent Street Cessnock Mine Hazard Risk Assessment, April 2009" by Parsons Brinckerhoff
- "Cessnock Civic Centre, Zone A Mine Subsidence Investigation – Interpretive Report, Jan 2010" by Parsons Brinckerhoff
- Letter from the Mine Subsidence Board to Cessnock City Council dated 25 November 2010

Appendix A

Flowchart for site geotechnical monitoring

Flowchart for Geotechnical Monitoring Program – Cessnock Civic



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Cessnock Civic Centre, Zone A Mine Subsidence Investigation - Interpretive Report

January, 2010

Hunter Land/Regional Land JV

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Revision	Details	Date	Amended By
Original	Draft Report	4 November 2009	Robert Kingsland
A	Revision A	21 December 2009	J. Anderson/I. Hill
B	Revision B	4 January 2010	I. Hill
C	Revision C	11 January 2010	

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Author: Robert Kingsland

Signed:

Reviewer: Jamie Anderson

Signed: JAnderson

Approved by: Ian Hill

Signed:

Date: 11 January 2010

Distribution: PDF; 4 bound copies

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Figures

1. Introduction

Parsons Brinckerhoff (PB) was commissioned by the Hunter Land/Regional Land joint venture to undertake a geotechnical investigation for Zone A of the proposed Cessnock Civic Centre development at Vincent Street, Cessnock. Zone A was delineated in the PB Mine Subsidence Hazard Risk Assessment report (Parsons Brinckerhoff Pty Ltd, 2009) and was considered to have a consistent mine working layout that was stable long-term.

The objectives and scope of this investigation were developed with reference to this report and discussions and correspondence with the NSW Mine Subsidence Board (MSB). The objectives of this investigation were:

- Confirm the stability of Zone A.
- Determine the boundary of Zone A with allowance for appropriate buffers.
- Consider impacts of past (including the June 2007 flooding) and future flooding and comment on the cause of observed cracking between Zone A and Zone C.
- Review/revise the pillar stability calculations based on the measured coal strength and including a sensitivity analysis for varying input (mining) parameters and consideration of the impact of subsidence on adjoining land.

The scope of the geotechnical investigation comprised:

- Drilling four cored boreholes and 26 percussion holes into the former Aberdare Extended Colliery workings using a truck mounted drilling rig.
- Monitoring the release of gas from the mine workings during drilling and within the seam/workings.
- Obtaining video footage of the underground workings using a down-hole camera.
- Strength testing samples of overburden rock and coal.

The report will reference the previous investigations performed on the site and will consider the proposed light industrial/commercial landuse. The particular focus of this report is the Zone A area and the adjoining zones where they may impact across the zone boundary and/or inform the understanding of Zone A.

This report is an interpretive report to the Zone A Mine Subsidence Investigation Factual Report (Parsons Brinckerhoff Pty Ltd, 2009). With the exception of the coal strength test results, all other investigation data is presented in this report.

In addition to the Zone A investigation results further detail in relation to acceptable development areas is also made for other areas of the site which include the areas not mined (Zones F and G) and the open cut area (Zone E). These development areas incorporate the comments made by the MSB in their letter dated 12 May 2009.

1.1 Project background

1.1.1 Previous investigations

Many reports have been prepared for the Cessnock Civic Centre site over several years. The reports of relevance to the current investigation are listed below:

- (Coffey Geosciences Pty Ltd, 2001) Rezoning for Civic Centre and Retirement Village off Vincent Street, Cessnock Geotechnical Urban Capability Assessment and Slope Stability Assessment for Harper Somers Pty Ltd, Coffey Geosciences Pty Ltd, N7719/1-AB, 3 April 2001.
- (GHD-Longmac Pty Ltd, 2001) Geotechnical Investigation of Mine Voids beneath Proposed Cessnock Civic Precinct Vincent Street, Cessnock, NSW for Hardie Holdings, GHD-Longmac Pty Ltd, 2710162, 14 August 2001 Rev.1.
- (GHD-LongMac, 2004) Report of Geotechnical Constraints for development of Former Aberdare Extended Colliery Site Cessnock, report to Hardie Holdings Dated 5 July 2004.
- (Parsons Brinckerhoff, December 2004) Proposed Cessnock Civic Centre, Vincent Street Cessnock – Geotechnical Management Plan, December 2004, Vincent Street Holdings Pty Ltd, Parsons Brinckerhoff, 2122471A PR_1484.
- (Parsons Brinckerhoff Pty Ltd, 2005) Proposed Cessnock Civic Centre, Vincent Street Cessnock – Mine Subsidence Investigation, June 2005, Vincent Street Holdings Pty Ltd, Parsons Brinckerhoff, 2122486A PR_0533.
- (Parsons Brinckerhoff Pty Ltd, 2009) Cessnock Civic Centre, Vincent Street Cessnock Mine Subsidence Hazard Risk Assessment, April 2009, Hunter Land/Regional Land Joint Venture, Parsons Brinckerhoff, 2122827B PR_0713 RevB.
- (Parsons Brinckerhoff Pty Ltd, 2009) Factual Report for Cessnock Civic Centre Zone A Mine Subsidence Investigation, September 2009, Hunter Land/Regional Land JV, Parsons Brinckerhoff, 2122827B PR_1732 RevA.

1.1.2 Mining history

The mining history for the site has been well documented in previous reports. Key aspects of the site's mining history as documented in the History of the Greta Coal Measures (Delaney, 1998) are noted below:

- The Aberdare Extended Colliery was opened in May 1906.
- Aberdare Extended Colliery only worked the main Greta Top Seam during its life.
- The maximum recorded thickness of the Greta seam within the Aberdare Extended Colliery lease holding was 34 feet (10.4 m) thick, but was typically 32 feet (9.8 m) thick.
- The dip of the seam was fairly uniform over the lease being 1 foot in 11 feet 6 inches (5 degrees) in a South 55° East direction.

- Two major faults ran across the lease from a north north-west direction to the south south-east. The first fault was 616 yards (563 m) in from the tunnel mouth. This fault had a down-throw of 50 feet (15.2 m). The second parallel fault was 1 mile 25 chains (2.01 km) from the tunnel mouth. This fault had an up-throw of 68 feet.

- In the mid 1940s, areas of the Aberdare Extended Colliery lease were operated by open-cut mining (known as the Caldare Open-Cut Colliery).

- In the open cut area the overburden was 30 feet (9.1 m) above the outcropping coal.

- In June 1949 torrential rain in the creek catchment above the Aberdare Extended Colliery lease lead to flooding of the open-cut hole which burst through into the Aberdare Extended underground workings via '2 West' section; causing considerable damage.

- Following this inrush of water it appeared that the pillars and general strata were badly affected as from that date the 'creep' and 'crush' increased in the pillars and workings causing disruption of efficient and economic mining operations and ultimately resulted in the pit's closure.

- Aberdare Extended Colliery in the late 1950s was having serious difficulty in operating its workings and was losing production due to creep and bad roof conditions.

- In early 1960 following a creep and crush within the Aberdare Extended Colliery lease, machinery and equipment had to be withdrawn.

- On 29 April 1960 Aberdare Extended Colliery finally ceased mining operations.

2. Geotechnical model

2.1 Subsurface conditions

The subsurface conditions documented in literature and based on the current investigation are presented under the following headings. A detailed description of the lithology and subsurface conditions is presented in the Zone A mine subsidence investigation factual report (Parsons Brinckerhoff Pty Ltd, 2009).

2.1.1 Regional geology

The 1:100 000 Newcastle Coalfield Regional Geology Map indicates that the site is underlain by conglomerate, sandstone and siltstone of the Branxton Formation and sandstone, conglomerate, siltstone and coal of the Greta Coal Measures. Structurally the site is located on the western limb of the Lochinvar Anticline in an area where minor normal faulting may be expected.

'A History of the Greta Coal Measures' (Delaney, 1998) mentions two faults that cut NNW-SSE through the Aberdare Extended Colliery. One fault was located 616 yards (563 m) from the tunnel mouth and had a down-throw of 50 ft (15.2 m) and the second was located 1 mile and 25 chains (2.01 km) from the tunnel mouth and had an up throw of 68 ft (20.7 m). Both of these faults fall outside of Zone A (the first passes through Zone E and H, at least 300 m from Zone A; the second does not fall inside the Cessnock Civic property).

2.1.2 Rock stress

In the Greta Coal Measures the major principal stress is oriented north-east and the ratio of major to minor horizontal stresses is approximately 1.4 (Lohe & Dean-Jones, 1995). The horizontal stress magnitude is relatively low, but generally exceeds the predicted vertical stress (Enever, Glen, & Beckett, 1998).

2.1.3 Geological section

The lithology is summarised in the geological section presented in Figure 2. The section is cut through the middle of Zone A between boreholes BH25 and BH27 as shown on Figure 1.

The lithology overlying the coal seam (i.e. the overburden) generally comprises silty/sandy clay residual soils to a depth of about 1 m overlying fine to medium grained sandstone with occasional coarse grained or conglomerate bands. The sandstone is generally high strength and is weathered to a depth of 6 m to 8 m at the northern end of the site increasing to 10 m to 11 m at the southern end of the site. The sandstone is thickly bedded (bed spacing greater than 2 m) near the surface but becomes laminated (spacing less than 20 mm) approximately 11 m above the top of the coal seam.

The top of the coal seam is encountered at a depth ranging from 17.2 m in borehole BH28 to 49.5 m in borehole BH25. The seam comprises medium strength interbedded coal and siltstone/claystone.

The core from the floor of the coal seam was recovered in boreholes BH01, BH02 and BH30 and comprised medium strength siltstone or fine grained sandstone.

2.1.4 Defects

The dominant defect encountered in the overburden rock was bedding partings which were horizontal/sub-horizontal and increased in frequency with depth from a spacing greater than 2 m where the sandstone was thickly bedded to a typical spacing of 250 mm to 500 mm in the laminated portion of the lithology above the coal seam.

Sub-vertical joints were also interspersed regularly throughout the rock mass with a typical spacing of 3 m (note: the joint spacing within the rock mass is likely to be less as the holes were all drilled vertically).

2.1.5 RQD

The rock quality designation (RQD) is noted on the geological section. The RQD is a quantitative indicator of rock quality as determined by frequency of defects. RQD is the ratio of the total length of rock core recovered in pieces of 100 mm or longer to the total length of the core run drilled, expressed as a percentage. The RQD values were generally good (75 to 90) to excellent (90+) in the upper thickly bedded rock and fair (50 to 75) to good in the lower laminated zone.

2.1.6 Groundwater

Perched groundwater was encountered at the northern and southern ends of the site. The workings, however, were generally dry across the site except where noted below.

Boreholes BH04, BH05, BH27 and BH28 at the northern end of the site all encountered perched groundwater at depths ranging from 2.3 to 5.5 m.

Boreholes BH22, BH23 and BH25 at the northern end of the site all encountered perched groundwater at depths ranging from 34.5 to 50.7 m. The down-hole camera images for BH23 revealed stalactite type growth from the roof of the void indicating long-term groundwater seepage. The perched water table encountered in BH22 was released into the void during the drilling process.

2.2 Coal strength

The PB mine subsidence hazard risk assessment report (Parsons Brinckerhoff Pty Ltd, 2009) noted that the Greta Coal Seam is known to be a strong coal and that this should be considered when assessing pillar stability. The strength of the Greta coal was measured as part of this current investigation to test this.

Samples of coal were taken from cored boreholes BH02, BH03 and BH30 were subject to point load testing in accordance with method AS 4133.4.1 - 2007 Determination of Point Load Strength Index. Three selected samples were sent to Australian Soil Testing, a NATA accredited laboratory for uniaxial compressive strength (UCS) with modulus in accordance with method AS 4133.4.3 – 1993 Determination of deformability of rock materials in uniaxial compression. One of these samples was unable to be tested for UCS due to transport damage. Point load testing was carried out on this sample instead of USC testing. The point load test reports and uniaxial compressive strength with modulus reports are presented in Appendix A and Appendix B respectively and the results are summarised in Table 1 and Table 2 respectively.

Table 1: Point load test results for coal samples

Borehole	Depth (m)	Point load strength, Is_{50} (MPa)	Test orientation	Failure type
BH01	52.42	1.03	diametral	not available[2]
BH01	52.42	1.12	axial	not available[2]
BH02	29.06	1.05	diametral	through substance
BH02	29.06	0.52	axial	through substance
BH02	32.36	1.12	diametral	through substance
BH02	32.36	0.42	axial	through substance
BH03	38.20	0.88	axial	along defect
BH03	40.15	0.54	axial	along defect
BH03	41.44	0.76	axial	through substance
BH30	53.35	0.42	diametral	bad break[1]

Note: 1. Bad break should indicate that result is greater than recorded value
2. Sample tested by Australian Soil Testing; all other testing by PB.

Table 2: Uniaxial compressive strength test results for coal samples

Borehole	Depth (m)	Position in seam	Uniaxial compressive strength, UCS (MPa)	Modulus, E (GPa)[1]	Poisson Ratio
BH03	41.6-41.86	Middle	17.9	2.7	0.286
BH30	54.5-54.70	Bottom	15.6	2.7	0.172

Notes: 1. Secant modulus calculated between 0 and 50% of the max. axial stress.

The coal strength test results indicate that coal strength is relatively uniform across the site and through the seam. The average uniaxial compressive strength value of 16.8 MPa and average point load strength result is 0.83 (excluding the bad break) which indicates medium strength as defined by AS1726 - 1993 (Standards Australia, 1993).

2.3 Mining

2.3.1 Verification of survey record

Previous PB drilling investigation at the Cessnock Civic Centre (Parsons Brinckerhoff Pty Ltd, 2005) has provided confirmation of the accuracy of the record tracing overlay of the site by the matching of roadway intersection and pillars encountered in the drilling and down-hole camera investigation with the same record tracing features.

The current investigation results, in particular the down-hole camera inspection of open boreholes, was compared against the record tracing overlay of the site. Table 3 presents the results of this comparison.

Table 3: Comparison of investigation results with the mine survey record

Borehole	Target feature	Feature encountered	Comments
BH01	Intersection of roadways	Roadway close to a pillar	Correlates
BH02	Edge of roadway near intersection	Roadway	Correlates
BH04	Roadway close to intersection	Roadway	Correlates
BH05	Intersection of roadway and split	Intersection	Good correlation
BH07	Intersection of roadways	Roadway	Correlates
BH09	Edge of pillar near split	Appears to be a roadway/split	BH07, BH08 and BH09 all encountered voids
BH10	In a split	In a roadway/split	Correlates
BH12	Roadway near intersection	Roadway	Correlates
BH16	Roadway near intersection	Roadway intersection	Good correlation
BH17	Roadway	Roadway	Good correlation
BH18	Edge of roadway near pillar and split	Pillar	Fair correlation
BH19	Roadway	Roadway	Correlates
BH20	Roadway intersection	Roadway	Correlates
BH21	Roadway near an	Roadway close to a pillar	Correlates

Borehole	Target feature	Feature encountered	Comments
	intersection		
BH22	Roadway near an intersection	Roadway, obscured view	Correlates
BH23	Roadway near an intersection	Roadway intersection	Good correlation

The results generally indicate a good correlation between the record tracing and the down-hole inspection of the workings for all boreholes inspected. Of particular note are the boreholes which confirmed the location of an intersection, as this provides confirmation of the survey record in both horizontal axes. Some of the inspections of boreholes targeting intersections only noted a roadway. This may indicate an error in position or may simply be a result of poor camera image quality or the obscuring presence of rubble.

Boreholes BH07, BH08 and BH09, though close together (within 20 m), all encountered voids. The record tracing shows borehole BH07 at an intersection but BH08 and BH09 near the edge of a pillar either side of a split. This finding suggests that the split was wider than shown on the record tracing.

Borehole BH18 encountered a pillar where the record tracing shows the edge of a roadway. The pillar is approximately 2 m from the borehole position.

The latest results provide further support that the record tracing overlay of the site is accurate to within a few metres.

2.3.2 Mining pattern

The History of the Greta Coal Measures (Delaney, 1998) provides the following information regarding the Aberdare Extended Colliery mining at the site:

- Was mined on the bord and pillar system of coal mining.
- Bords were 8 yards (7.3 m) wide.
- In the first years, pillars were made 15 yards (13.7 m) wide.
- The cut-throughs were 4 yards (3.7 m).
- Bords and cut-throughs were run in at a slight incline to allow water to drain back to the main and side headings.
- First workings were planned to be at a height of 9 feet (2.7 m).
- A local inspector in the mid 1940s reported 27% of the mine output from falls.
- The first tops coal was extracted in 1912; when the tops were extracted, the workings height averaged 16 to 18 feet (4.9 m to 5.5 m) but rose in places to 20 feet (6.1 m) and occasionally 24 feet (7.3 m).

- The pillar splits were normally 6 yards (5.5 m) wide.

PB Mine Subsidence Hazard Risk Assessment (Parsons Brinckerhoff Pty Ltd, 2009) identifies three distinct panel layouts occur under the site; these are:

2.3.2.1 Zone A and B

The strike of the seam (north-easterly) was utilised in this section of the mine to provide favourable grades for running loaded coal trucks to the main entries, which were excavated by open cut mining in the early 1960s. This, coupled with the use of horses for coal haul meant that pillars were cut as parallelograms rather than squares or rectangles. The parallelogram shape is consistent throughout the section, but the lengths of the pillars changed from approximately 25 m in the first 9 rows (Zone B) to around 30-37 m in the pillar rows closest to Vincent Street (Zone A). When the pillars were split (cross hatching of the splits suggests that tops were taken in the splits) the remnant two pillars remaining each side of a split were larger than in those rows closer to the main entry roadways (Zone D).

The roadway (bords) widths are wide compared with modern practice, at 8 yards (7.3 m), while the connecting roadways (cut-throughs) are 4 yards (3.7 m). Pillars were split and it appears that the splits were commonly 6 yards (5.5 m) wide regardless of the size of the original pillar.

2.3.2.2 Zone C

The pillars are oriented east-west in Section No. 2 east. The change in pillar orientation is marked by three rows of solid pillars. Although the width of the pillars remained similar to those in the section up-dip, the lengths changed, as did the direction of splitting. The end result is a section with smaller remnant pillars than the previous mine section up-dip. These smaller pillars are also at greater depth, exceeding 50 m.

2.3.2.3 Zone D

Close to the original main entries to the mine there is a small section of square pillars, with sides approximately 14 m length that have almost been completely removed and collapsed. It was sealed due to heating, but 4 years after sealing the open cut mined into the western side of this section. A single row of solid pillars separates this partly collapsed section from the main unnamed mine, which affects the site.

2.4 Surface subsidence features

Table 4 summarises the subsidence features that have been recorded and observed at the Cessnock Civic Centre site. These features are also noted on Figure 1.

Table 4: Subsidence features noted at the Cessnock Civic Centre site

Date	Subsidence feature	Location	Source of information	Comments
1930s	Circular subsidence 100 m in diameter.	Near borehole BHE.	(Coal & Allied Operations Pty Limited, 29 March 1994).	Thought to caused by pillar failure following a heating.

Date	Subsidence feature	Location	Source of information	Comments
1965	Circular subsidence 50m in diameter; some cracking outside the perimeter.	West of borehole BH14.	(Coal & Allied Operations Pty Limited, 29 March 1994).	Up to 1 m subsidence at the centre.
2005	Hummocky ground and several circular features, 10 to 20 m dia. and 0.5 m deep.	In vicinity of borehole BHD.	(Parsons Brinckerhoff Pty Ltd, 2005).	
June 2007	Large (50 m dia, 20 m deep) sinkhole Small potholes noted around main feature.	In Zone E, adjacent Black Creek.	Observed Parsons Brinckerhoff.	Associated with major storm event and flooding of Black Creek.
June 2007	Cracking and small subsidence feature.	Near southern boundary of Zone A.	Observed Parsons Brinckerhoff.	Associated with major storm event.
2008	Several topographic anomalies thought to be subsidence features.	One in Zone D and throughout Zone B.	(Parsons Brinckerhoff Pty Ltd, 2009).	Survey by Harper Somers O'Sullivan; Job Ref: 22257.
2009	Several potholes up to 5 m dia.	Zone D goaf area.	Current investigation.	Venting shaft noted nearby.
2009	Cracking.	Extending south-west of borehole BH21 in Zone B.	Current investigation.	

2.5 Condition of workings

2.5.1 Pillars and roof

A detailed presentation of the results of the down-hole camera survey of the site is presented in the accompanying PB factual report (Parsons Brinckerhoff Pty Ltd, 2009).

The key subsurface subsidence features in the roof and pillars are summarised in Figure 7.

2.5.2 Mine atmosphere

Gas monitoring and temperature readings were taken to assess any spontaneous combustion activity in the workings, either recent or presently occurring. Assessment of spontaneous combustion in coal is based on the presence of carbon monoxide, and the temperature of mine atmosphere. The results are reported in full in the PB Zone 2 factual report (Parsons Brinckerhoff Pty Ltd, 2009). The results indicate that no spontaneous combustion activity has recently or is currently occurring. The current very low oxygen levels would not be able to support combustion.

However, the results do indicate a temperature gradient from south to north (lower temperature in the south) and higher oxygen content in the south.

The ground cracking to the south of the site and the presence of the venting shaft and potholes in Zone D to the north (see Figure 1) indicate movement in the mine atmosphere up-dip (to the north).

In view of the above and the history of spontaneous combustion at this site it is recommended that:

- all cracks be sealed
- potholes be backfilled
- the venting shaft be sealed.

These actions will help to control the mine atmosphere such that combustion cannot be supported.

2.5.3 Convergence of seam

When pillars fail or compress across an area the top of the seam moves closer to the floor. This is termed 'convergence'. Convergence observed in a borehole may indicate pillar compression or failure depending on the magnitude.

The Greta Seam thickness recorded by site history for the Aberdare Extended Colliery was 9.8 m typically, with 10.4 m maximum.

An average of the seam depths was taken from boreholes across the site excluding the boreholes that had indications of significant seam convergence. The average obtained was 9.83 m, which compares closely with the historical record. The measured seam height was compared to this average and all convergence values greater than 0.1 m are noted. These convergence values are also noted on Figure 7.

Bore Hole	Greta Seam Depth (m)	Floor (m)	Seam height (m)	Comments	Convergence (m)
BH 01	48.6	57.7	9.1	Convergence	0.7
BH 02	28.25	38.4	10.15		
BH 03	37.7	47.2	9.5	Convergence	0.3

Bore Hole	Greta Seam Depth (m)	Floor (m)	Seam height (m)	Comments	Convergence (m)
BH 04	24.4	34.7 *	10.3		
BH 05	19.0	29.2 *	10.2		
BH 07	38.8	45.65 *	6.85	May not have reached floor	
BH 08	38.9	45.8*	6.9	May not have reached floor	
BH 09	38.7	45.4 *	6.7	May not have reached floor	
BH 10	40.6	45.7 *	5.1	May not have reached floor	
BH 12	32.4	42.2 *	9.8		
BH 13	40.3	50.2	9.9		
BH 17	45.2	54.55 *	9.35	Convergence	0.5
BH 18	43.8	53.55 *	9.75		
BH 19	40.85	50.4 *	9.55	Convergence	0.3
BH 20	47.7	57.4 *	9.7		
BH 21	46.3	54.3 *	8	Possible convergence; Inferred floor	1.8
BH 22	49.7	59.65 *	9.95		
BH 27	23.35	33.15 *	9.8		
BH 28	17.2	27.45 *	10.25		
BH 29	28.15	37.6	9.45	Convergence	0.4
BH 30	46.12	54.83	8.71	Convergence	1.1
BHA	13.60	22.8	9.2	Possible convergence	0.6
BHB	21.40	31.52	10.12		
BHC	33.30	43.25	9.95		

Bore Hole	Greta Seam Depth (m)	Floor (m)	Seam height (m)	Comments	Convergence (m)
BHD	41.29	50.55	9.26	Convergence	0.6
BHF	26.96	37.16	10.2		

Note: * inferred floor from increased drilling resistance, no recovery.

The convergence indicated for borehole BH21 may be false as the floor was only logged from increased resistance as no sample recovery occurred. The down-the-hole camera observation noted rubble on the floor.

Note: the elastic compression of the seam pillars due to the induced vertical stress resulting from the bord and pillar mining would be less than 0.1 m.

3. Analysis

3.1 Pillar stability

3.1.1 Method of analysis

Pillar stability was analysed using the University of New South Wales (UNSW) method which is based on the probabilistic back-analysis of failed and stable pillars from a database spaning Queensland, New South Wales and South Africa (Galvin, Hebblewhite, & Salamon, 1999). This method is widely accepted and used throughout the world.

The input parameters and outputs for this method are noted on the spreadsheet which is presented in Appendix C.

The method uses a different algorithm for squat pillars; i.e. where the ratio of width to height is greater than 5. The computed factor of safety is based on the applicable algorithm. A pillar is considered long-term stable if the computed factor of safety is 2 or greater. This equates to a probability of failure of 1 in 100,000.

The spreadsheet also presents two alternate methods of analysis, Bieniawski and Salamon & Munro, which were precursors to the UNSW method. The alternate methods are used as a cross-check on the UNSW method. This report will present results from the UNSW method only unless stated otherwise.

The UNSW method is applicable to parallelepiped shaped pillars; i.e. pillars with a parallelogram base. Where the pillars are parallelepiped shaped, as is the case at this site, the width of the pillar used is the minimum width, not the side length.

3.1.2 Influence of coal strength

The average uniaxial compressive strength value of 16.8 MPa indicates medium intact strength for the coal tested. This strength is mid range for coal with reference to NSW coalfields experience (Holt, 2004) and international data (Mark & Barton, 1997). Analysis of data sets from South Africa, Australia and the United States has shown that the value of in situ coal strength in pillars falls between 5.4 MPa and 7.4 MPa (Mark & Barton, 1997) and University of NSW analysis of Queensland and NSW bord and pillar workings has shown that in situ pillar strength is influenced by seam stength (albeit marginally) where the width to height ratio (w/h) exceeds 2 (Galvin, Hebblewhite, & Wagner, 1995).

Previous pillar analysis for the Cessnock Civic site (Parsons Brinckerhoff Pty Ltd, 2009) has indicated that many pillars have w/h ratios in excess of 2. Therefore, some consideration of the Greta Seam strength should come into the analysis of pillar strength for this site. However, given the mid-range strengths obtained and the slight impact that coal seam strength has on pillar strength, the measured Greta Seam strength is considered unlikely to have a great influence on the analysis outcomes.

3.1.3 Depth of cover

The depth of cover isopachs are shown on Figure 3. These isopachs take into account the current and previous investigation drilling results and the base of seam and surface contour information. The depth indicated is to the mined seam. The depth to the mined seam was used rather than the depth to workings for clarity as the mined height varies across the site and even in adjacent workings (e.g. bords c.f. splits). The depth to the Greta Seam varies from 16 m in the north to 51 m in the south, but is in the range 30 m to 45 m for most of the site.

3.1.4 Homogeneous sections

The site is divided into homogeneous sections for pillar stability analysis based on:

- geometry of workings and mine layout
- depth of cover to workings
- proximity to adjoining areas of differing geometry/layout.

The homogeneous sections are shown in Figure 3 and are group by colour and numbering into Zone A and other adjacent zones (Zones B, C, D and U). Zone U is the "unclassified" area to the east of the site.

The characteristics of each of the zones is described in Table 5 and the key geometric parameters are noted in presented in Section 3.1.5.

Table 5: Homogeneous zones for pillar stability analysis

Zone	Description
A1	Shallow workings, mix of larger split pillars and un-split pillars adjacent to Zone D
A2	Un-split pillars along northern boundary of Zone A
A3	Large split pillars, shallow depths
A4	Large split pillars along boundary with Zone B, shallow depths
A5	Large split pillars along boundary with Zone B, intermediate depths
A6	Large split pillars, intermediate depths
A7	Large pillars, unevenly split, intermediate depths
A8	Large split pillars along eastern boundary, intermediate depths
A9	Narrower split pillars along Zone A southern boundary
A10	Small split pillars in south-western corner of Zone A

Zone	Description
B1	Smaller split pillars along Zone A boundary at shallow depths
B2	Smaller split pillars along Zone A boundary at intermediate depths
B3	Smaller split pillars along Zone A boundary at greater depths
B4	Un-split pillars adjacent to south-west corner of Zone A
C1	Deeper mined area with spilt pillars
C2	Area of large first working pillars along the southern boundary of Zone A
D1	Line of large square pillars in the north-west corner of the site, between Zone A and the Zone D goaf
U1	Unclassified area to the east of the site; large pillars, some unmined

3.1.5 Dimensional parameters

The width of the bords, cut-throughs and splits indicated in the mining history (Delaney, 1998) are 7.3 m, 3.7 m and 5.5 m respectively.

When the record tracing is examined the bords, cut-throughs and splits are of a consistent width across the study area. Three representative measurements were taken across Zone A to compare with the mining historic. The results of this comparison are presented in Table 6. The adopted parameter was the greater of the historic record and the average measurement. In the case of a spilt pillar, the dimension b2 is a cut-through on one side and a split on the other. Therefore in determining the tributary area, b2 is the average of the cut-through and spilt dimensions; in this case 4.9 m.

Table 6: Bord, cut-throughs and splits dimension comparison

Measurement	Bords	Cut-throughs	Splits
width 1	7.27	4.23	5.02
width2	6.28	4.1	5.38
width 3	7.63	4.63	5.02
average	7.06	4.32	5.14
historical	7.3	3.7	5.5
adopted	7.3	4.3	5.5

The pillar heights considered are the based on the mine history record that the first workings were to a height of 2.7 m and tops coal was extracted to a typical height of up to 5.5 m (note: the tops appears to be only taken in the splits) and up to 6.1 m in places.

The results of the drilling programme can be compared to this historic record. Table 7 presents the void height data collected from the current and previous PB drilling investigation (Parsons Brinckerhoff Pty Ltd, 2005). Voids have been included that are located within Zone A, lie within the coal seam and are not related to workings collapse.

Table 7: Summary of voids encountered within the Greta Seam

Borehole	Void height (m)	Comments
BHB	4.0	Roadway near intersection
BHF	4.6	Roadway near split
BH01	3.81	Roadway close to a pillar Voids through seam were summed
BH02	3.0	Roadway
BH03	4.2	Roadway near pillar
BH04	4.15	Roadway
BH05	3.6	Intersection
BH12	4.9	Roadway
BH17	4.35	Roadway
BH19	4.5	Roadway
BH20	4.95	Roadway
BH21	3.0	Roadway close to a pillar
BH22	4.5	Roadway
BH27	2.1	Edge of pillar near roadway
BH28	2.6	Intersection

This data indicates a minimum void height of 2.1 m, a maximum void height of 4.95 m and an average of 3.84 m. It is likely that some roof falls have occurred since mining to account for the greater measured working height than the historic record. The boreholes were all in roadways (bords or cut throughs) and none were in splits where the tops appears to have been taken. Therefore it is suggested that the pillar analysis consider three pillar heights; namely,

- the average measured working height of 3.8 m ('low pillar')
- the maximum measured working height of 4.95 m ('intermediate pillar')
- where pillars are split, the expected upper bound height of 6.1 m ('high pillar').

For each homogeneous section two pillars have been analysed; one representing the typical conditions, and one representing the lower bound ('worst case'). For Area A9 four pillars have been analysed; a typical and lower bound case for each of the southern and northern portions of this area.

Pillar plan dimensions have been taken from the record tracing.

3.1.6 Results of analysis

The stability analysis output is presented in Appendix C and summarised in Table 8.

Table 8: Pillar stability analysis results

Section		Pillar FOS			Comment
		Low pillar (h=3.8m)	**Intermediate pillar (h=4.95m)**	**High pillar (h=6.1m)**	
Area A1	typical	7.9	6.2	5.4	Stable
Area A2	typical	9.7	7.7	6.7	Stable
Area A3	typical	5.5	4.3	3.8	Stable
Area A3	lower bound	3.7	2.8	2.4	
Area A4	typical	5.2	4.2	3.6	Stable
Area A5	typical	3.1	2.4	2.1	Stable
Area A6	lower bound	3.1	2.4	2.1	Stable
Area A7	typical	4.6	3.7	3.2	Marginally stable
Area A7	lower bound	2.4	**1.8**	**1.6**	
Area A8	typical	4.4	3.5	3.1	Stable
Area A8	lower bound	2.8	2.2	**1.9**	
Area A9 - south	typical	3.4	2.9	2.5	Stable

Section		Pillar FOS			Comment
		Low pillar (h=3.8m)	Intermediate pillar (h=4.95m)	High pillar (h=6.1m)	
Area A9 - south	lower bound	2.5	2.1	**1.9**	Stable
Area A9 - north	typical	3.6	3.0	2.6	
Area A9 - north	lower bound	2.9	2.4	2.1	
Area A10	typical	2.5	2.0	**1.7**	Unstable
Area A10	lower bound	2.1	**1.6**	**1.4**	
Area B1	typical	4.3	3.3	2.9	Marginally stable
Area B1	lower bound	2.4	**1.8**	**1.6**	
Area B2	typical	3.0	2.3	2.0	Marginally stable
Area B2	lower bound	2.4	**1.8**	**1.6**	
Area B3	typical	2.0	**1.5**	**1.3**	Unstable
Area B4	typical	4.6	3.5	3.1	Stable
Area C1	typical	4.5	3.4	3.0	Stable
Area C2	typical	3.1	2.5	2.2	Marginally stable
Area C2	lower bound	2.1	**1.7**	**1.4**	
Area D1	typical	11.8	9.8	8.5	Stable

Note: **bold** indicates unstable (long term) factors of safety.

The following definitions have been adopted:

Stable – factor of safety (FOS) for typical and lower bound pillars are 2 or more (note: may include zones where the lower bound FOS for the high pillar is marginally less than 2).

Marginally stable – FOS for typical pillars is 2 or more and lower bound intermediate (and high) pillars is less than 2 or FOS for typical pillars is significantly more than 2 and all lower bound pillars are less than FOS 2 (provided that the lower bound pillars represent less than 50% of all pillars for the area.

Unstable – FOS for typical and lower bound pillars less than 2 or FOS for typical intermediate (and high) pillars is less than 2.

These results are presented graphically in Figure 5.

3.1.7 Dimensional variation (sensitivity analysis)

The pillar dimensions can vary from those shown on the record tracing. Some of the reasons for variation include:

- spalling of coal at the edges of the pillar (particularly where stresses higher)
- survey error (inaccuracies in the record tracings)
- taking more coal than shown on survey
- erosion of the pillars by seepage and weathering.

To account for these variations the pillar stability analysis has been repeated to allow for a 0.5m loss of coal on all faces; i.e. a total loss of 1.0m in both plan dimensions. The consequences of this reduction are:

- for a typical 7m wide pillar; a 14% loss of width
- for a typical 15m long pillar; a 7% loss of length
- for a typical 7m x 15m pillar; a 20% loss in plan area.

An increase in the bords on both sides by 1 m.

The pillar stability analysis sensitivity check results are presented in Appendix D and summarised in Table 9.

Table 9: Pillar stability sensitivity check results

Section		Pillar FOS			Comment
		Low pillar (h=3.8m)	Intermediate pillar (h=4.95m)	High pillar (h=6.1m)	
Area A1	typical	6.2	5.2	4.5	Stable
Area A2	typical	8.3	7.0	6.1	Stable
Area A3	typical	4.4	3.7	3.2	Stable
Area A3	lower bound	2.7	2.3	2.0	
Area A4	typical	4.3	3.6	3.1	Stable
Area A5	typical	2.4	2.0	**1.8**	Stable
Area A6	lower bound	2.4	2.0	**1.7**	Stable
Area A7	typical	3.8	3.2	2.8	Marginally

Section		Pillar FOS			Comment
		Low pillar (h=3.8m)	Intermediate pillar (h=4.95m)	High pillar (h=6.1m)	
Area A7	lower bound	**1.7**	**1.5**	**1.3**	stable
Area A8	typical	3.5	3.0	2.6	Stable[1]
Area A8	lower bound	2.1	**1.8**	**1.5**	
Area A9- south	typical	2.8	2.3	2.0	Marginally stable
Area A9-south	lower bound	**1.9**	**1.6**	**1.4**	
Area A9 - north	typical	2.9	2.4	2.1	Marginally stable
Area A9 - north	lower bound	2.2	**1.9**	**1.6**	
Area A10	typical	**1.9**	**1.6**	**1.4**	Unstable
Area A10	lower bound	**1.4**	**1.2**	**1.1**	
Area B1	typical	3.2	2.7	2.4	Marginally stable
Area B1	lower bound	**1.6**	**1.3**	**1.1**	
Area B2	typical	2.2	**1.9**	**1.6**	Unstable
Area B2	lower bound	**1.7**	**1.4**	**1.3**	
Area B3	typical	**1.4**	**1.2**	**1.0**	Unstable
Area B4	typical	3.8	3.2	2.8	Stable
Area C1	typical	3.8	3.2	2.8	Stable
Area C2	typical	2.5	2.1	**1.8**	Unstable
Area C2	lower bound	**1.5**	**1.3**	**1.1**	
Area D1	typical	9.8	8.3	7.2	Stable

Note: **bold** indicates unstable (long term) factors of safety.

1. Area A8 has been classified as stable as the lower bound pillar is an isolated smaller pillar surrounded by larger stable pillars.

These results are presented graphically in Figure 6.

3.1.8 Influence of adjoining mining areas

Where a panel of coal is removed, as in long wall mining, the overburden rock will collapse and sag into the void left. Some of the overburden load from the sagging rock will transfer to the coal beyond the edge of the panel. This is referred to as abutment load or stress. The compression of the coal seam due to abutment stress translates to the ground surface as subsidence.

The extent of the abutment stress can be approximated by considering the angle of draw. The angle of draw is shown along with a number of other common mine subsidence terms in Figure 3-1 (source: Holla, 1987).

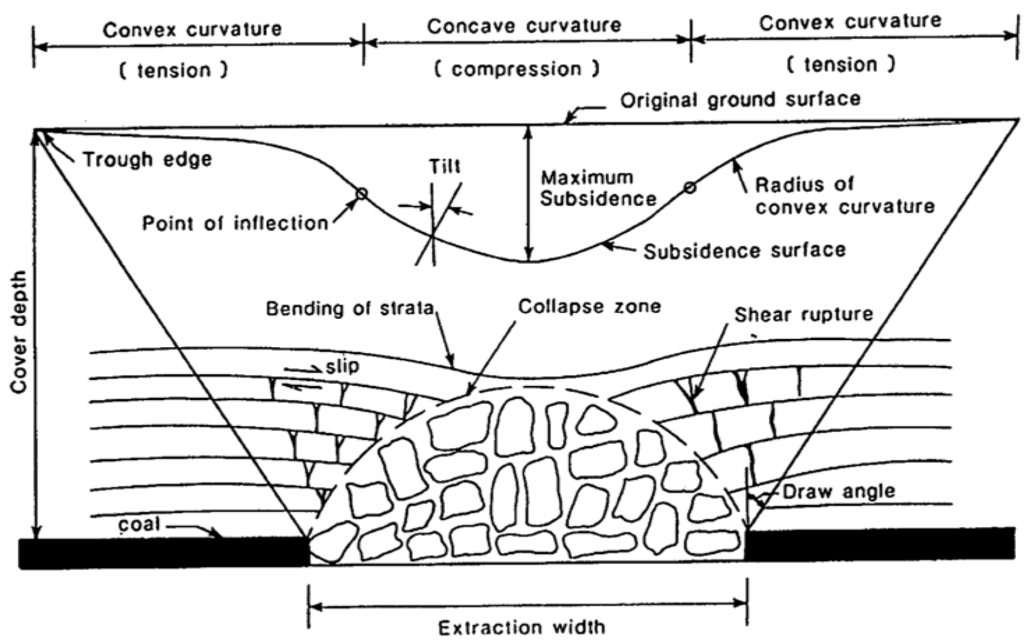

Figure 3-1: Effect of a large underground excavation (source: Holla, 1987)

The angle of draw may be defined as the angle from vertical extended upwards from the edge of the extracted coal panel beyond which mine subsidence would not normally be encountered. The angle of draw for NSW coalfields would normally be taken as 26.5 degrees.

The areas of particular concern are:

The area adjacent to the goaf in Zone D to the north-west of Zone A; can the collapsed workings in Zone D impact the Zone A area?

The Zone B area noted as unstable; is/has a collapse of workings in Zone B likely to impact the adjacent Zone A area?

These questions will be discussed in turn:

Zone D

For Zone D: abutment loading can extend up to approximately 10 m beyond panel edge. The abutment pillars in this area are large with much residual capacity (FOS>9) and adjacent

Zone A site pillars also have much residual capacity (FOS>5). Therefore it is unlikely that abutments will collapse and less likely that a collapse would propagate into the site.

Zone B

If Zone B collapses the abutment loading can extend up to 25 m into the site. The adjoining pillars in Zone A have a typical factor of safety of about 3. Therefore it is also unlikely that the abutments will collapse though some surface subsidence impacts may be expected in this area.

3.1.9 Influence of flooding past and future

In June 2007 torrential rain lead to local flooding of Black Creek and triggered pothole subsidence in the vicinity of the confluence of Black Creek and an un-named tributary in Zone E west-south-west of the Zone A site. One pothole was near enough to Black Creek for the creek flows to be diverted into the pothole which subsequently led to the pothole enlarging to a 100 m diameter sinkhole nearly 30 m deep. A large volume of water entered the workings and flowed down-dip to the south-east.

At the same time two parallel surface tension cracks opened up near the Zone A southern boundary.

The site history (Delaney, 1998) records that in June 1949 flooding of the open-cut to the west of Zone A occurred which burst through into the Aberdare Extended underground workings causing considerable damage (refer Section 1.1.2).

The section of Black Creek affected by the 2007 flood event has been restored and lined. Outside this section, where Black Creek passes through the Cessnock Civic Centre site is either not undermined or has large first working pillars remaining. The potential for a recurrence of the 2007 event is greatly reduced.

To examine the impact that flooding may have had on the stability of pillars in Zone A the flooding potential and flooding impacts for the workings have been considered.

Figure 8 illustrates key levels and potential flow paths which may have lead to the flooding of the underground workings in Zone A. Based on the floor of seam levels (GHD-Longmac Pty Ltd, 2001) the base of the 2007 sinkhole would have been RL 43 m AHD.

The RL 43 floor contour indicates that most of the site is below the RL 43 m contour. However, the site is at least 420 m to the north-east of the water entry point into the workings and the dip direction is south-east. Photos taken at the time of the sinkhole show that the water from Black Creek drained into the open workings to the west-south-west (Photo 1). Based on the dip to the south-west it is expected that the stormwater flowed generally in this direction and most likely through the existing workings under Black Creek and into Zone H. If some former workings still existed to the east of the sinkhole in Zone E some stormwater may have been directed south-east and ultimately travelled down dip through Zone C.

Photo 1: Aerial view of 2007 sinkhole, looking south

Photo 2: View from Black Creek towards the 2007 sinkhole

It is likely however, that seepage water from the elevated groundwater or backwater resulting from the flood would have reached the Zone A site. However, it unlikely that flows of any significant erosion velocity would have passed through the workings under the Zone A site.

The potential impacts of elevated water levels in the Zone A workings include:

- softening of floor
- erosion of pillar
- subsidence triggered.

Softening of the floor can lead to a pillar punching failure and resulting subsidence. The floor of the Greta Seam at this location has been logged as a low to medium strength carbonaceous siltstone with a strength similar to the coal seam above. Boreholes BH23, 27, 28 were all observed to be wet (borehole BH23 indicated stalactites indicating long term wet conditions), but gave noticeable resistance when the floor was encountered. It is unlikely that subsidence related to floor softening has resulted from the flood water entry.

As noted above the velocities of the seepage water in Zone A related to the flooding event are unlikely to have caused detachment and transport of coal from the pillars. However, some degradation of pillars may occur as a result of long term seepage flows over/through a pillar, leading to spalling and loss of pillar width/length. These effects have been taken into account with the sensitivity analyses reported in Section 3.1.7.

The cracking along the southern boundary of Zone A coincided the June 2007 storm event. However, it is unlikely that the flooding of the workings to the south-west of the site associated with this event had a great impact on the workings in Zone A. The observed cracking was more likely initiated by rainfall infiltration and seepage movement, as rainfall is closely associated with observed subsidence events (Singh, 2007).

Further discussion of the cracking to the south of the site is given in Section 3.4.

3.1.10 Correlation with evidence

With reference to Figure 6 and 7 there is a good correlation between convergence and areas noted marginally stable and unstable. The highly fragmented pillar condition in borehole BH30 also matches well with its position on the edge of an unstable area.

The good correlation between the sensitivity analysis outcomes and the site subsidence evidence indicates that this pillar modelling is a better fit than the initial pillar stability computations and should be adopted.

3.2 Pothole subsidence

3.2.1 Pothole risk

The potential for pothole subsidence can be assessed by considering four key causative factors; namely, depth of workings, strength of overburden, faults and fracturing and presence of water (Singh, 2007).

The pothole subsidence potential is assessed using the rating method proposed by Singh for two subdivisions of the Zone A site separated by the 30 m isopach contour; namely north of the 30 m contour and south of the 30 m contour. The results of the ratings are presented in Table 10.

These ratings give a qualitative rating of very low to low risk of pothole subsidence for the Zone A site.

Table 10: Pothole subsidence risk rating

Factor	North of 30 m isopach		South of 30 m isopach	
	Category	**Rating**	**Category**	**Rating**
Depth of workings	15-30m	30	30-50m	20
Overburden rock strength, UCS	10 to 15MPa	10	>15MPa	0
Faults and fracturing	closely spaced joints (5 per m)	5	Moderately spaced joints (<2 per m)	0
Water seepage in exposed roof in workings	Suspended drops	5	Trickling drops[1]/dry	10/0
TOTAL SCORE		50		30/20
RISK RATING	Low risk		Very low risk	

Note: 1. Southern boundary of south area noted groundwater, elsewhere in this area workings are dry.

3.2.2 Required overburden depth

The down-hole camera evidence (refer Figure 8) shows signs of partial to complete roof collapse in the southern half of the site. If this roof failure is able to propagate to the ground surface then a pothole will form.

To assess whether there is potential for this roof failure to propagate to the ground surface in the form of a pothole feature, the bulking property of fractured rock should be considered. When the roof collapses, the volume occupied by the fractured rock is greater than the volume occupied by the intact rock. Where the depth of workings is sufficient, it is feasible for the roof collapse to continue until the void is filled and the rubble can support the overlying rock (Roberts, 2007).

Reported bulking factors (Hynes, 1987) for sandstone and siltstone are in the range 1.25 to 1.30, which indicates a volume increase of 25 to 30% or a bulking coefficent of 0.25 to 0.3. The estimated thickness of overburden to fill a void is given by Equation 2:

$$d = t / [(v_f - v_i)/v_i]$$ **Equation 1**

Where d = thickness of overburden to fill the void, t = the void height and $(v_f - v_i)/v_i$ is the bulking coefficient (v_i and v_f are the initial and final rock volumes).

Using a maximum expected void height (t) of 6.1m (for areas where tops were taken, and a bulking coefficient of 0.25 to 0.3, the calculated thickness to fill the void (d) is 24.4 to 20.3 m. A pothole will normally form at the intersection of roadways and for this location the maximum measured roadway height and average measured roadway heights of 4.95 m and 3.8 m will yield calculated thicknesses to fill the void of 19.8 to 16.5 m and 15.2 to 12.7 m respectively.

3.2.3 Pothole propagation

With reference to Figure 1 and Section 2.4, potholes have been observed in Zone D where the depth of overburden is 18 m or less and full extraction has occurred. No potholes have been noted in the shallow cover areas within Zone A.

Based on the site evidence, the assessed risk of pothole formation and the calculated overburden height to fill voids, it is considered that pothole formation is unlikely in areas where the cover to workings is greater than 20 m and there are no voids present. The presence of the thickly bedded sandstone from approximately 11 m above the seam to the surface provides additional protection against the propagation of a pothole to the surface.

3.3 Subsidence estimates

The implication of pillar failure in the marginally stable area A9 can be assessed by calculating subsidence parameters and comparing these values with reference standards.

Maximum surface subsidence parameters can be estimated with reference to NSW Department of Mineral Resources guidelines (Holla, 1987). The recommended average maximum subsidence parameters for critical and supercritical extraction conditions are:

- Subsidence, Smax = 0.55 x T (m).
- Tensile Strain, +Emax = 400 x Smax/H (mm/m).
- Compressive strain, -Emax = 600 x Smax/H (mm/m).
- Tilt, Gmax = 1800 x Smax/H (mm/m).

Where: T = effective extracted seam thickness; H = the depth of the workings

These parameters are illustrated diagramatically in Figure 3-2 (source: Holla, 1987).

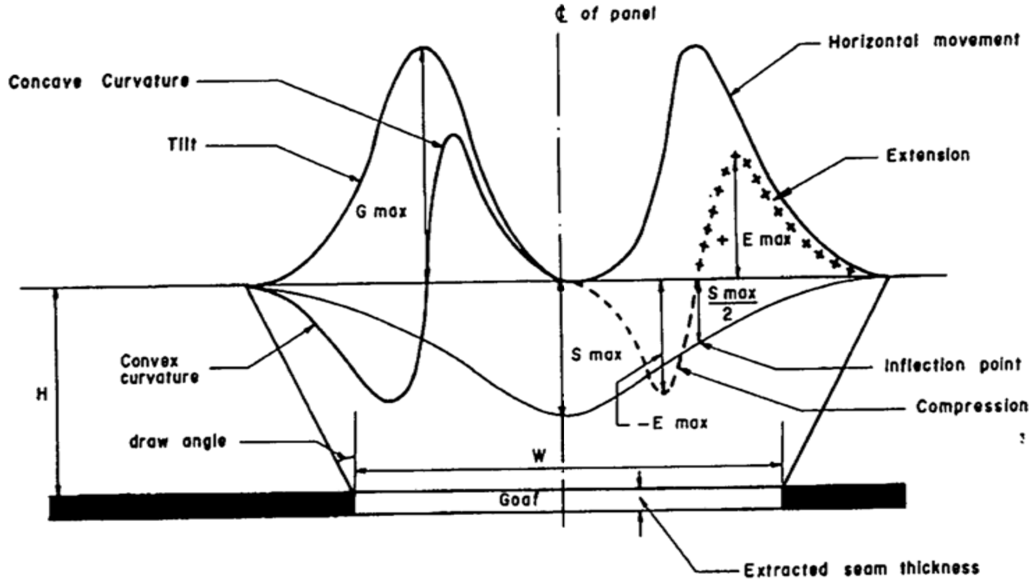

Figure 3-2: Characteristics of trough subsidence (source: Holla, 1987)

Critical and supercritical extraction conditions are those where the extracted panel width (W) is equal to or greater than 1.6H. These empirical relationships have been developed for longwall mining. However, the subsidence impact of collapse of bord and pillar workings can be estimated using these relationships. In this case the effective extracted seam thickness is the average working height multiplied by the extraction rate; i.e. the ratio of the coal extracted to the total volume of coal in the worked height of the seam.

Using Area A6 as typical of the site, the extraction ratio has been estimated as 70% making allowance for tops being taken in the split pillars.

For H = 44 m; T= 3.8 m (average measured height of workings) x 0.70 = 2.7 m and supercritical conditions (i.e. the failed panel is 70 m wide or greater), the following avearge maximum subsidence parameters are given:

- Smax = 1.49 m.
- +Emax = 13.5 mm/m.
- -Emax = 20.3 mm/m.
- Gmax = 61 mm/m.

These values are maximum estimates and may be reduced where the panel width is sub-critical; i.e. less than 1.6H and the thickly bedded sandstone bridges across the panel width.

For comparison, Standards Australia in AS2870 – 1996 (Standards Australia, 1996) provides maximum differential movements for various types of construction. Ranging from 40 mm or L/300 mm for clad frame to 10 mm or L/2000 mm for full masonry.

These values correspond to maximum tilts ranging from 0.5 mm/m for full masonry to 3.3 mm/m for clad frame construction.

Therefore Area A9 is deemed unsuitable for building construction due to the unacceptably high potential subsidence parameters.

3.4 Cracking to the south of Zone A

With reference to Figure 3-2, where trough subsidence is occurring, the maximum tension occurs at the edge of the extracted seam slot.

With reference to Figure 6, the tension cracking observed in 2007 occurs above the boundary between the stable first working pillars in Area C1 and the marginally stable pillars in Area A9.

Figure 7 also shows that there has been some seam convergence north of these cracks.

Based on this evidence it is concluded that the cracking along the southern boundary of Zone A has been caused by seam compression north of the stable Area C1.

Similarly, the more recent tension cracking observed during this current investigation (refer Figure 6) occurs above the boundary between the stable first working pillars in Area C1 and B4 and the unstable pillars in Area B3 and is on the same line as the earlier cracking.

It is likely that the cracking in this location along the southern boundary of Zone B has been caused by seam compression north of the stable areas. Although there is no convergence data in this location, there are a number of subsidence features north of the crack supporting this conclusion.

4. Zone A development

4.1 Boundaries

With reference to the Section 3.2.3 discussion about pothole risk and propagation, development boundary limits are proposed which:

- preclude building development using slab construction in pothole prone areas to the north of the site where the cover to the seam is less than 20 m
- preclude building development using slab construction in part of the marginally stable (A9) and unstable areas (A10) along the southem margin on Zone A.

Area A7 is indicated as marginally stable however, this is based on the low factor of safety on the small spilt pillars. The other pillars in Area A7 and the adjoining areas (A6 and A8) have typical factors of safety of about 3. Therefore as the small pillars in Area A7 become more stressed, they will shed load to the adjoining larger pillars that have ample residual capacity. Accordingly, Area A7 has not been excluded from development.

The marginally stable area A9 has been examined more closely to provide better definition of stable and unstable/marginally stable areas. Based on the results of pillar stability analysis and dimensional checks, individual pillars in area A9 and the adjoining areas C1 and C2 have been classified as stable, marginally stable and unstable. The results of this analysis are presented in Figure 9.

This analysis shows that the pillars in the western portion of A9 are generally stable, whilst the pillars in the eastern portion of A9 are generally unstable. On the results of this analysis the eastern portion of A9 should be precluded from building development. This is shown as Zone A(3) on Figure 11.

4.2 Buffers

If pillars in unstable and marginally stable areas crush, load will be transferred to adjacent areas leading to additional stress and compression of the pillars in these abutment areas (refer to Section 3.1.8 discussion about abutment loading and angle of draw). The buffer should be set such that crushing of the adjacent pillars will not lead to subsidence impacts on the adjacent land nor pillars in the adjacent areas be stressed to the point of significant compression or collapse.

These objectives can be met by checking that the buffer be at least the angle of draw distance from the edge of the unstable and marginally stable areas and that the adjacent pillars have an adequate residual factor of safety (so that they can accommodate some additional load without failure). In view of this the following offsets are proposed:

- North-west comer nominal 10m offset from the 20 m isopach.
- The western boundary offset is at the angle of draw from the unstable and marginally stable Areas B1/B2 and the adjoining pillars have a typical factor of safety of 3 or more.

- The southern boundary offset is set at the angle of draw from the unstable portion of Area C2.
- Angle of draw offsets are also indicated from the unstable portion in the east of Area A9.

The total buffer area is shown as Zone A(2) on Figure 11.

The building development boundaries using slab construction and incorporating the above buffers are shown in Figure 10 and more clearly as Zone A(1) on Figure 11.

4.3 Development

It is proposed to develop the site for either commercial/industrial usage. This type of development is feasible for the Zone A site (and over the stable pillars in Zone C1) within the boundaries and buffers discussed above.

The Mine Subsidence Board (MSB) will place restrictions on the types and construction of structures that can be erected on the site based on the mining history and the mine subsidence hazards present at the site.

The following guidelines would be typical for the proposed landuse:

Commercial/industrial guidelines

- Single storey, steel framed improvements clad with steel, or tilt-up slab construction, with single storey masonry amenities and office blocks, designed in accordance with the relevant codes and standards. These improvements may be limited to a maximum length of 50 m and a maximum height of 12 m.

Other types of construction may be permissible based on their merits and the design justification.

In areas where the cover to workings is 20 to 25 m (this is a small portion in the north-west corner of Zone A(1) there may be an additional requirement for footings to be designed to span a nominal 5 m diameter pothole. It is recommended, even though the pothole risk has been shown to be very low, that the pothole design requirement be applied across the entire Zone A(1) area within the approved building envelope.

Within the buffer Zone A(2) construction of buildings shall have piled foundations below the existing workings.

No construction is advised in Zone A(3). This area should only be used for parking and hardstand areas.

5. Zone E, F and G development

The previous 'Mine Subsidence Hazard Risk Report' dated April 09 as well as ongoing discussions with the MSB have confirmed that outside Zone A the most suitable developable areas are Zones E, F and G which are either not undermined or are backfilled open cut areas. The developable areas within these zones are discussed further in this section.

5.1 Zone E

The previous 'Mine Subsidence Hazard Risk Assessment' report confirmed that Zone E was the area of the former open cut mine which has been backfilled.

The area was assessed as suitable for development subject to:

- Confirmation of the open cut boundary between Zone E and Zones B, D and H.
- Confirmation that underground workings are not present in the southeast section of the backfilled open cut area.

These points were raised during the consultation process with the MSB.

Instead of proceeding with the geotechnical fieldwork to confirm the outstanding points, it is proposed to implement buffer setbacks across both the eastern boundary of Zone E and the south eastern corner. This will initially reduce the developable area of Zone E and allow these areas to be investigated in the future.

Based on the angle of draw calculations completed for the Zone A/B boundary it is recommended that 20 m would be an acceptable setback from Zones B and D to Zone E. Given the proven accuracy of the record tracings and the initial test pitting on site a further 5 m is considered a conservative estimate to allow for any variance in the open cut boundary location. Thus a total setback of at least 25 m is recommended for the boundary of Zone E to the east. This is shown as Zone E(2) in Figure 11.

Comments made by the MSB's subconsultant Arthur Love have raised the possibility of existing workings in the south eastern corner of Zone E. As discussed we propose to provide a setback over this area. Based on the record tracings we have delineated the area of possible underground workings, noted as Zone E(3) on Figure 11, and then provided an additional conservative 20 m setback, Zone E(2), to account for angle of draw if the workings are present. The revised developable area is shown on Figure 11.

As discussed in the previous 'Mine Subsidence Hazard Risk Report' the area noted as Zone E(1) is suitable for construction of buildings subject to excavation and recompaction to a depth of 3 m to provide a bridging layer over the uncompacted fill to minimise future settlement.

Construction in Zone E(2) would require piling below the existing depth of backfilled open cut or underground workings. Buildings which span over the boundary between Zones E(1) and E(2) shall be designed to incorporate changes in settlement due to different foundations.

No construction is advised in Zone E(3), which includes the location of the former sinkhole as well as possible existing underground workings, until further detailed subsurface investigation is completed.

5.2 Zone F

As described in the 'Mine Subsidence Hazard Risk Assessment' report the area in Zone F is not undermined and is suitable for development. It is noted that the MSB letter dated 12 May 2009 concurs with this view.

It is recommended that prior to development occurring the old drifts in this area need to be dug out. This developable area is shown in Figure 11.

As this area is not undermined construction of buildings in accordance with the required Australian standards would apply. It is recommended to avoid spanning buildings across the Zone F boundary due to changes in settlement conditions.

5.3 Zone G

As described in the 'Mine Subsidence Hazard Risk Assessment' report the area in Zone G us not undermined and is suitable for development. It is noted that the MSB letter dated 12 May 2009 concurs with this result.

This developable area is shown in Figure 11.

As this area is not undermined construction of buildings in accordance with the required Australian standards would apply. Again, it is recommended to avoid spanning buildings across the Zone G to Zone E(1) boundary due to changes in settlement conditions.

6. Conclusion

This report provides interpretation supporting the PB factual report (Parsons Brinckerhoff Pty Ltd, 2009) on the geotechnical investigation for Zone A of the proposed Cessnock Civic Centre development at Vincent Street, Cessnock. Zone A was defined by the Mine Subsidence Hazard Risk Assessment (Parsons Brinckerhoff Pty Ltd, 2009) based on panel layouts and an assessment of pillar stability.

The current work was commissioned to confirm the stability of Zone A; determine the boundary of Zone A with allowance for appropriate buffers; consider impacts of past and future flooding, comment on the cause of cracking between Zone A and Zone C; review/revise the pillar stability calculations based on the measured coal strength and sensitivity analysis for varying input parameters; and consider the impact of subsidence on adjoining land.

The scope of the geotechnical investigation consisted of an extensive drilling programme using coring and percussion drilling of holes, monitoring of gases from the mine workings during drilling and within the seam/workings, down-hole camera inspection of workings and strength testing of overburden rock and coal.

The drilling programme confirmed the accuracy of the record tracing survey record to within a few metres and revealed varying condition of workings ranging from intact pillars and minor roof spalling to compressed or crushed pillars and collapsed roof conditions. These results aligned well with the predicted pillar conditions.

Laboratory testing found the coal strength mid-range and unlikely to have a bearing on the results of stability analysis.

The results of gas monitoring indicated that no spontaneous combustion activity has recently or is currently occurring. However, in view of the above and the history of spontaneous combustion at this site it is recommended that all cracks be sealed, potholes be backfilled and the venting shaft (north of the site) be sealed.

Detailed pillar stability analysis was performed; Zone A was subdivided into 10 areas and the adjacent Zone B, C and D were divided into another seven areas. Sensitivity analysis was carried out to take into account potential survey inaccuracies and pillar degradation.

With sensitivity analysis the results indicate marginally stable and unstable areas in Zone B to the west, marginally stable and unstable areas along the southern margin of Zone A, a stable band of pillars in Zone C immediately south of the boundary and unstable areas in the deeper parts of Zone C. These results are shown in Figure 6. Convergence of the seam roof towards the floor and pillar crushing was observed in areas that were found to be marginally stable or unstable. The cracking along the southern boundary of Zone A was found to be caused by seam compression in the southern portion of Zone A north of the stable Area C1.

Pothole subsidence analysis considered the risk of subsidence and the potential for pothole propagation to reach the ground surface. It was found that the risk of pothole formation at the site is very low to low and should not propagate to the surface in areas where the cover to workings is greater than 20 m and where there are no voids present in the overburden.

Empirical subsidence estimates found that collapse of workings could not be tolerated by the proposed building development in the eastern portion of Area A9 at the site due to excessive tilts.

The proposed building development boundaries for Zone A are shown in Figure 10 and are based on:

- precluding development using slab construction to the north of the site where the cover to the seam is less than 20 m
- precluding development in the unstable areas along the southern margin of Zone A
- buffers to marginally stable and unstable areas based on the angle of draw (ranging from 10 to 25 m)
- a buffer to the pothole prone area of 10 m.

Within this development area for the Zone A site (and the portion of Zone C1 over stable pillars) the proposed commercial/industrial development is feasible subject to Mine Subsidence Board restrictions on structure.

In addition Zones E, F and G were reviewed in accordance with recent MSB correspondence. Zones F and G are not undermined and are considered suitable for development while the Zone E development boundary is based on:

- excluding the sinkhole and area of possible workings to the south east
- providing a 20 m buffer from the marginally stable and unstable Zones B, D and H which are yet to be investigated
- providing an additional 5 m buffer to account for any variation in the boundary of the backfilled open cut area.

The following table describes the development areas and constraints as shown in Figure 11.

Zone	Description	Building constraints
A(1)	Stable pillars	Slab design to span 5 m potholes.
A(2)	Buffer zone and shallow workings	Pile to below existing workings.
A(3)	Marginally stable, unstable pillars	No building construction/parking, hardstand only.
B	Yet to be investigated in detail	No development.
C(2)	Yet to be investigated in detail	No development.
D	Yet to be investigated in detail	No development.
E(1)	Backfilled open cut	Excavation and recompaction to 3 m.

Zone	Description	Building constraints
E(2)	Buffer-backfilled open cut/existing workings	Pile to below existing workings.
E(3)	Sinkhole/possible underground workings	No development.
F	Not undermined	Standard slab construction.
G	Not undermined	Standard slab construction.
H	Yet to be investigated	No development.

Figure 12 provides an overall indication of the site development area while the proposed rezoning plan is supplied in Appendix F.

7. Limitations

This report should be read in conjunction with the appended 'Limitations of Geotechnical Site Investigation' (Appendix E), which provide important information regarding geotechnical investigations and assessments. Any changes to the scope of development of this site, or significant variation in subsurface conditions from those anticipated should be reported to PB for reassessment.

8. References

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Figures

Client: Hunter Land
Project: Cessnock Civic Centre Zone A Geotechnical Investigation
Location: Vincent Street, Cessnock

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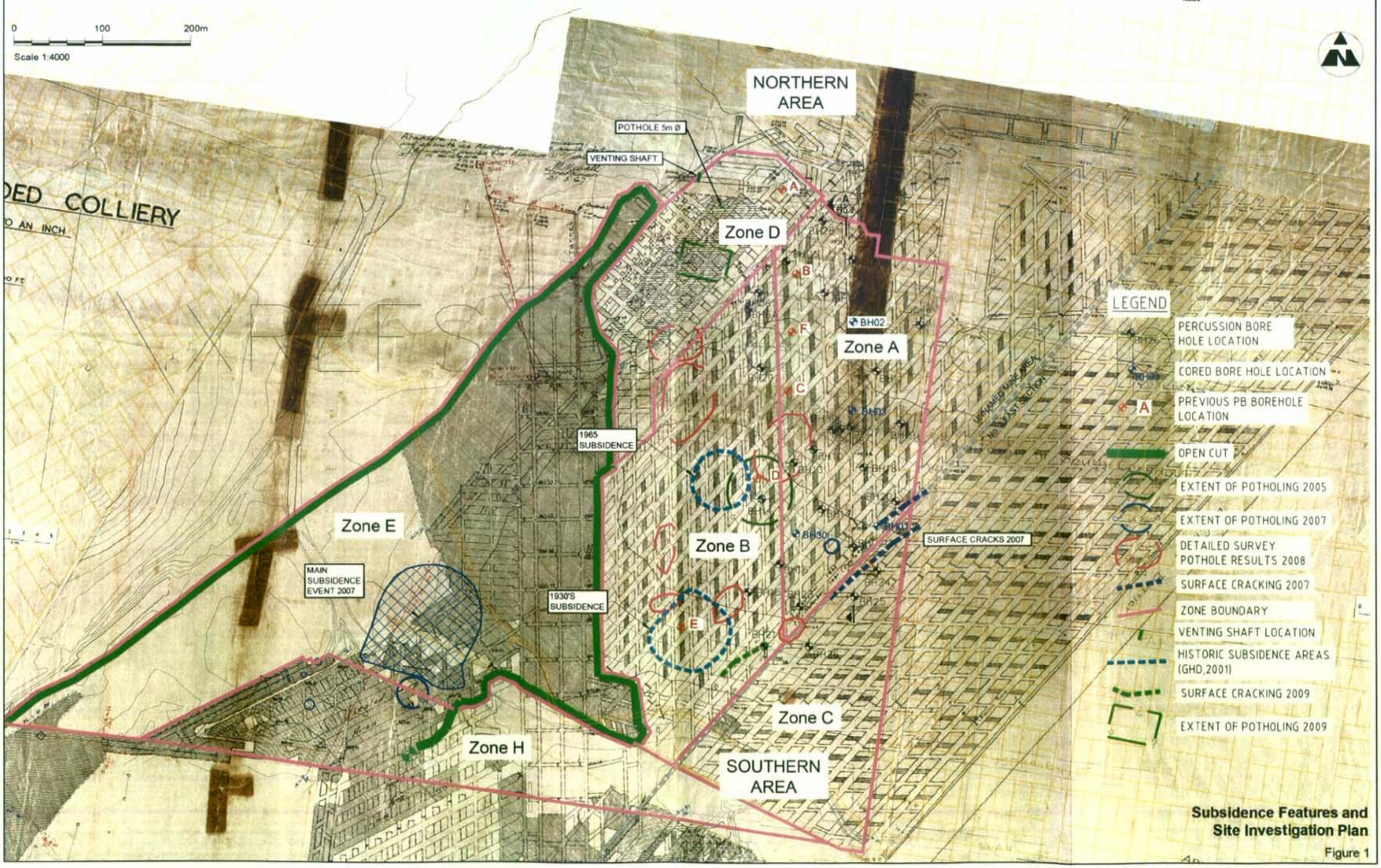
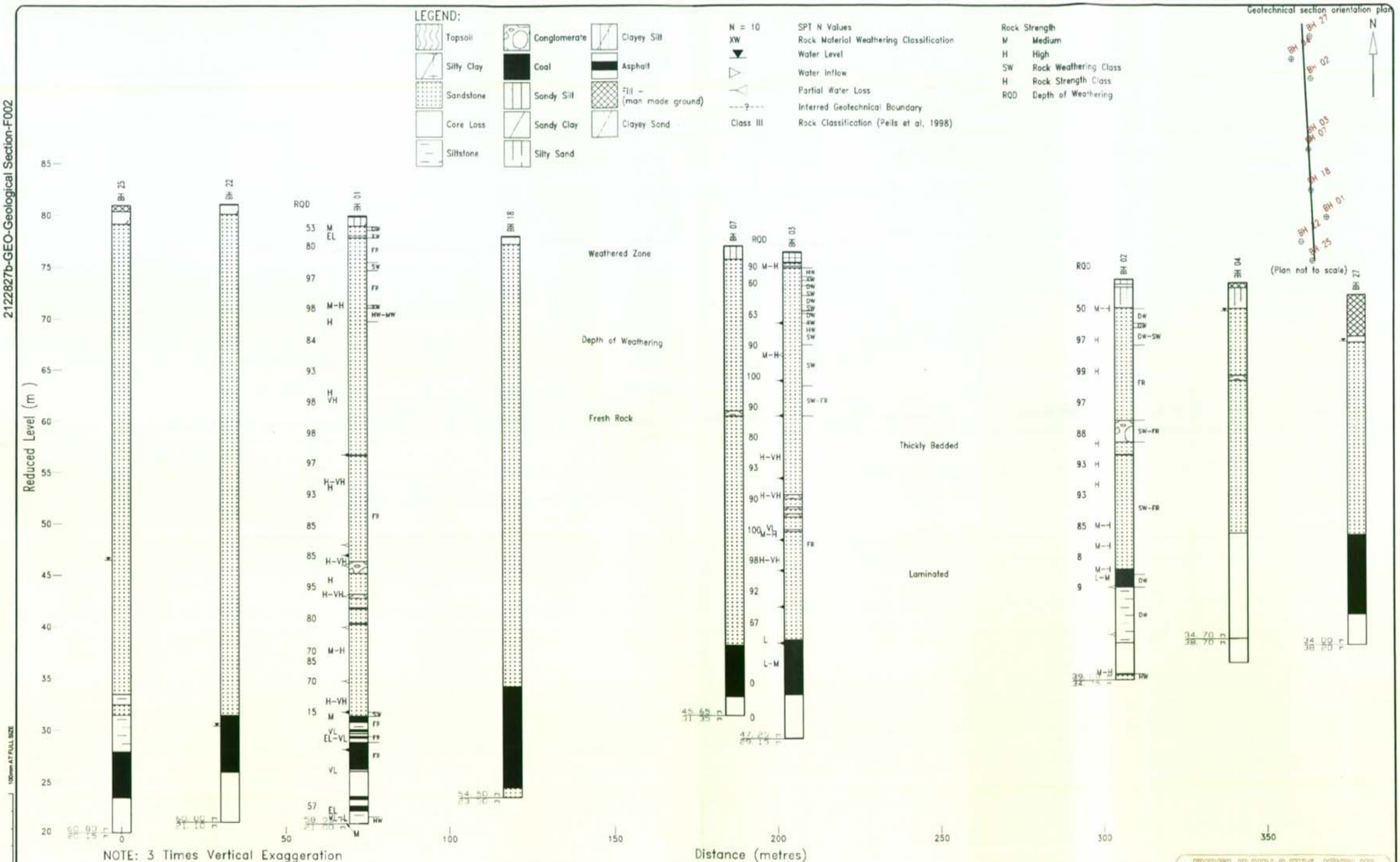


Subsidence Features and Site Investigation Plan

Figure 1



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A	16.10.09		DOB	AS			

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CLIENT

PROJECT
HUNTER LAND
VINCENT STREET, CESSNOCK
ZONE A MINE SUBSIDENCE INVESTIGATION
FIGURE 2 - GEOLOGICAL SECTION

PROJECT No.	TASK	DISCIPLINE	NUMBER	REV
2122827B –		– GEO –	002	A

Client: Hunter Land
Project: Cessnock Civic Centre Zone A Geotechnical Investigation
Location: Vincent Street, Cessnock

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Scale 1:4000

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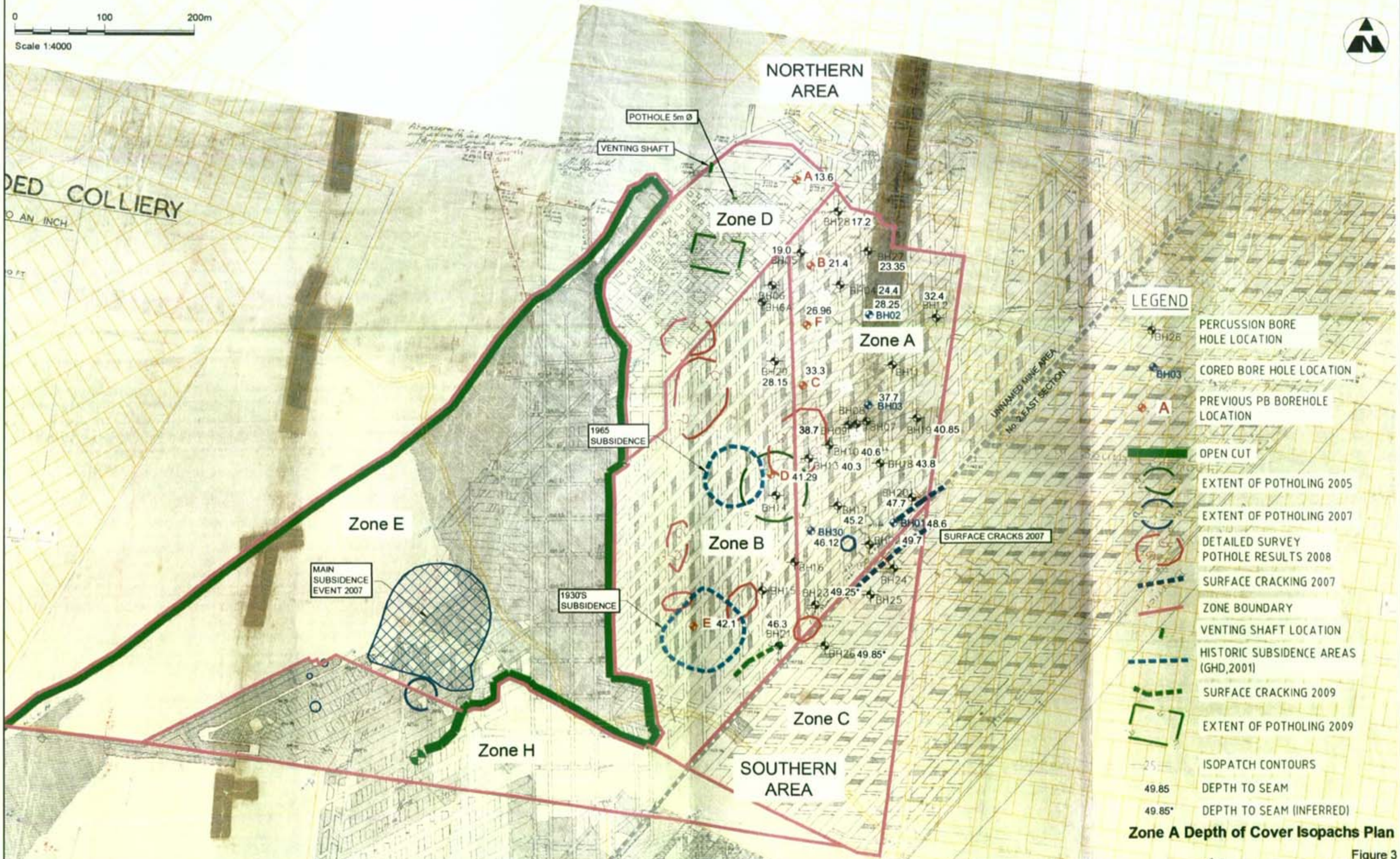
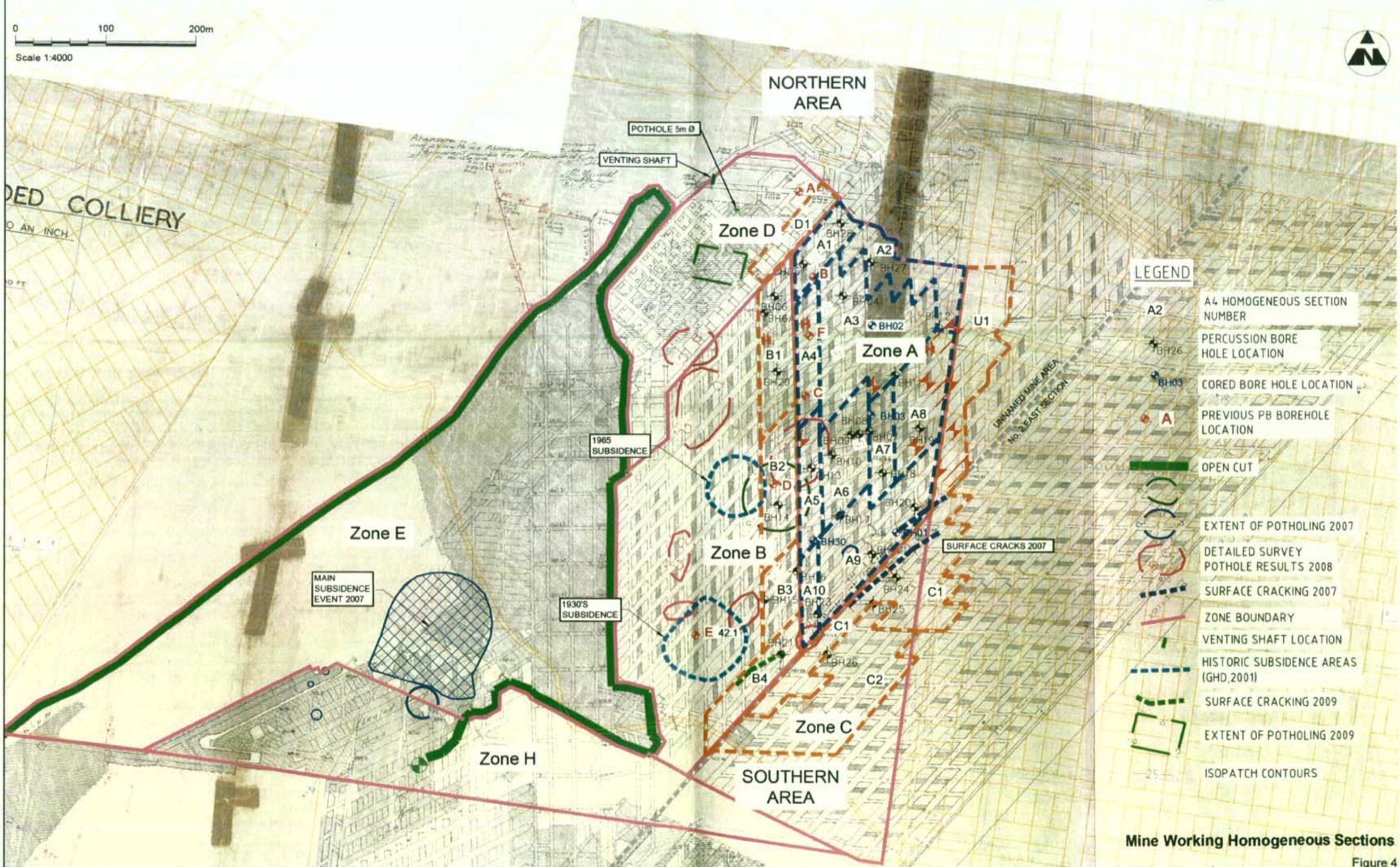


Zone A Depth of Cover Isopachs Plan

Figure 3

Client: Hunter Land
Project: Cessnock Civic Centre Zone A Geotechnical Investigation
Location: Vincent Street, Cessnock



Mine Working Homogeneous Sections

Figure 4

Client: Hunter Land
Project: Cessnock Civic Centre Zone A Geotechnical Investigation
Location: Vincent Street, Cessnock

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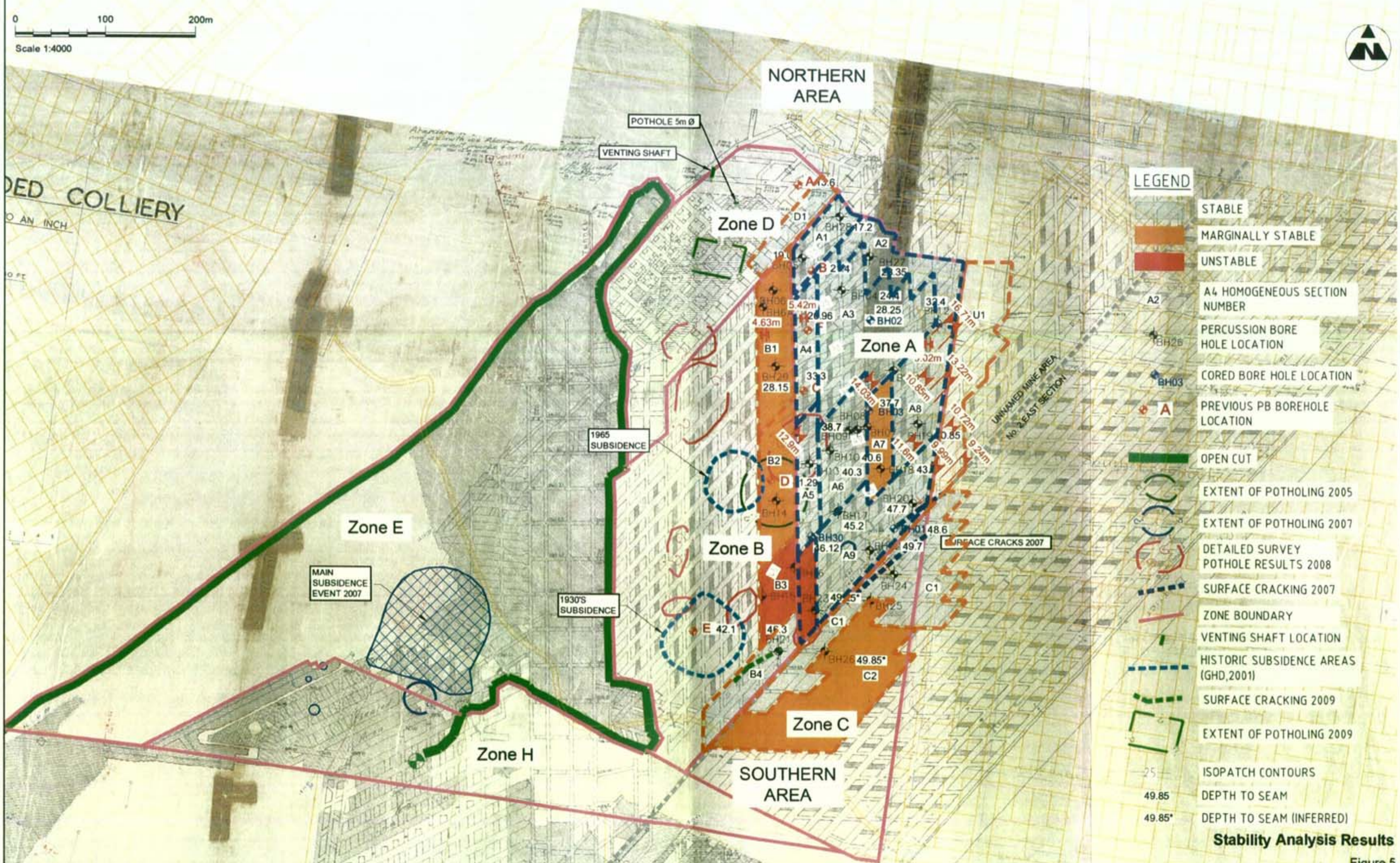

Stability Analysis Results

Figure 5

Client: Hunter Land
Project: Cessnock Civic Centre Zone A Geotechnical Investigation
Location: Vincent Street, Cessnock

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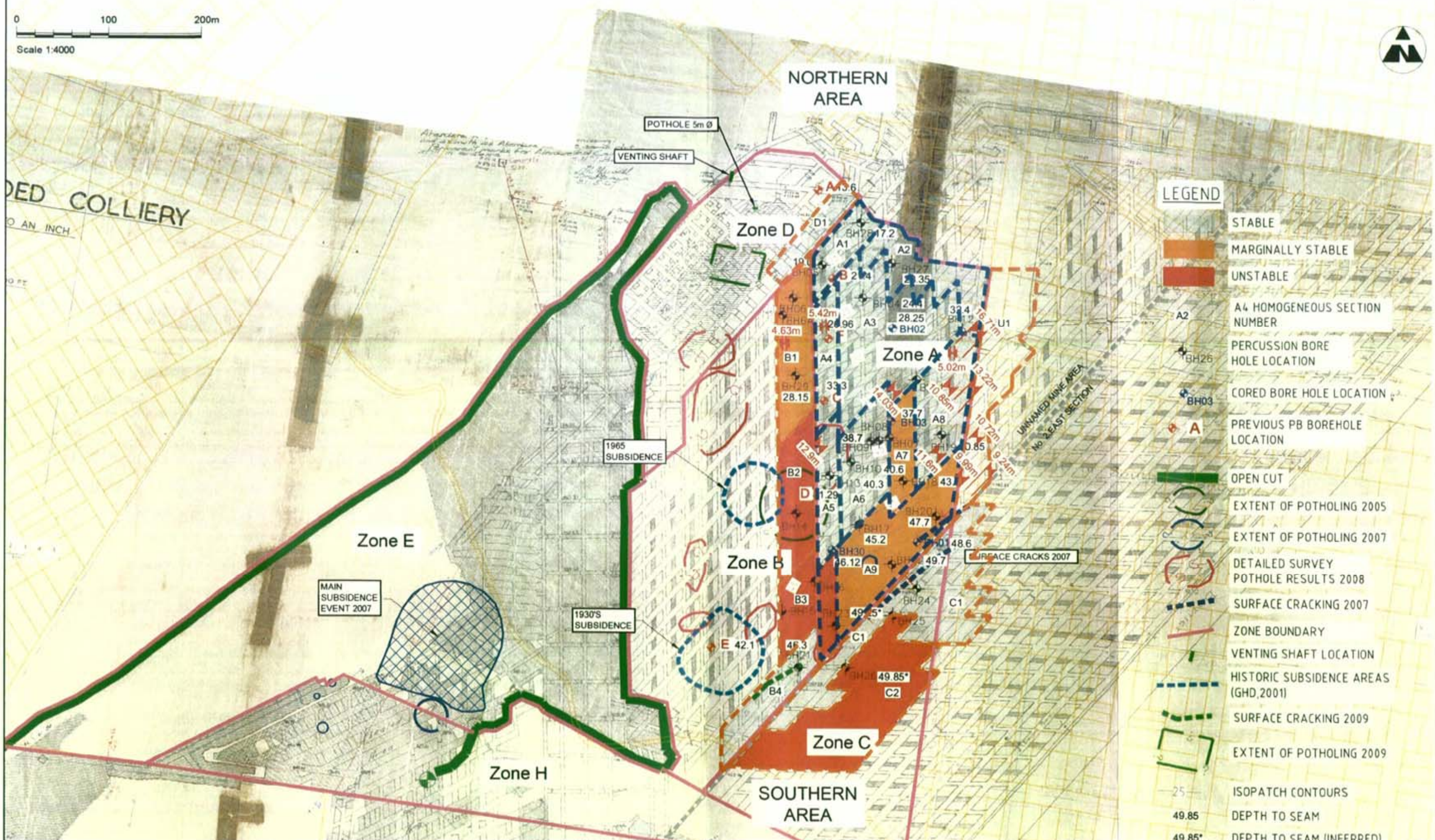
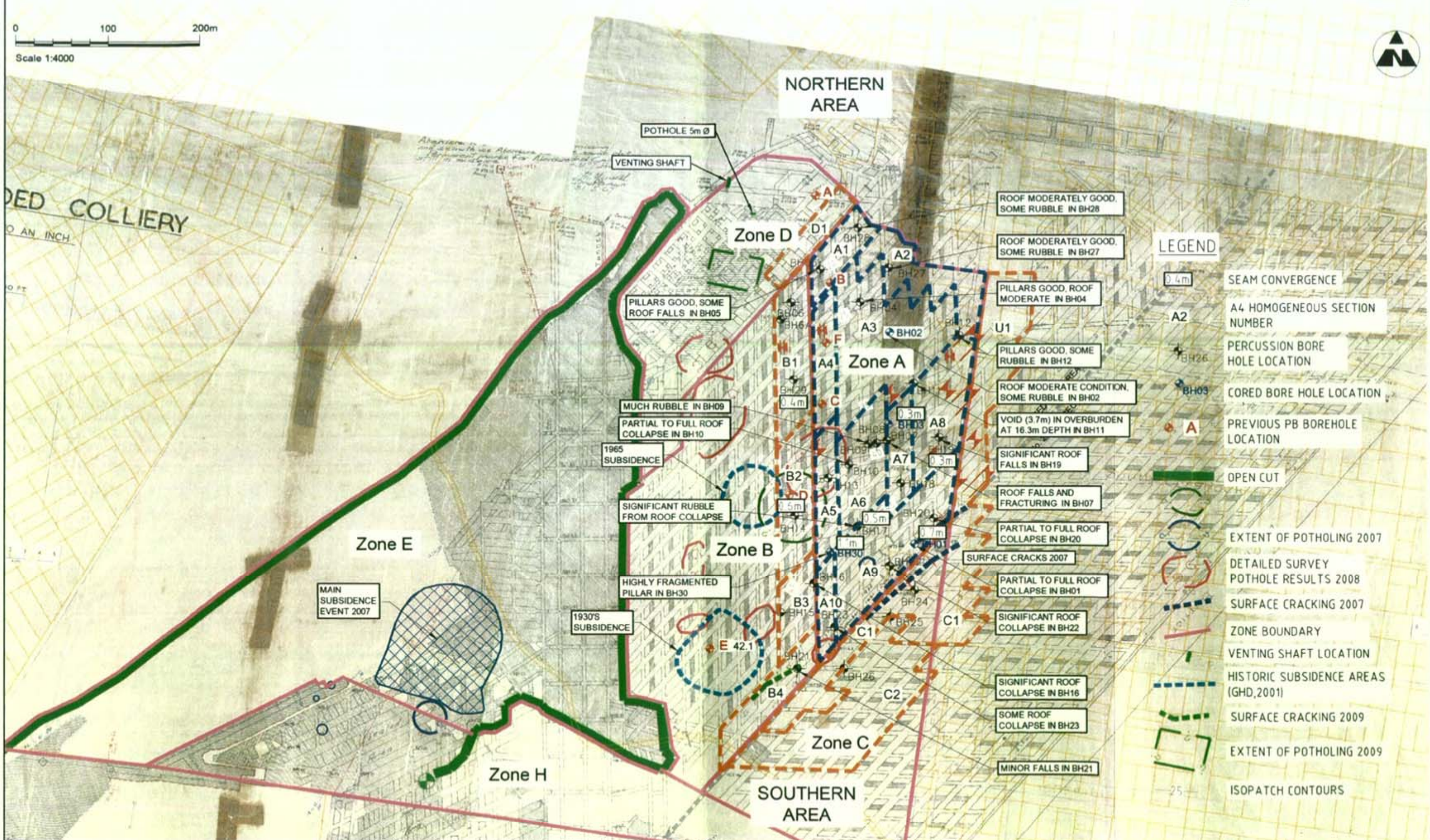


Stability Analysis Results, Small Pillars

Figure 6

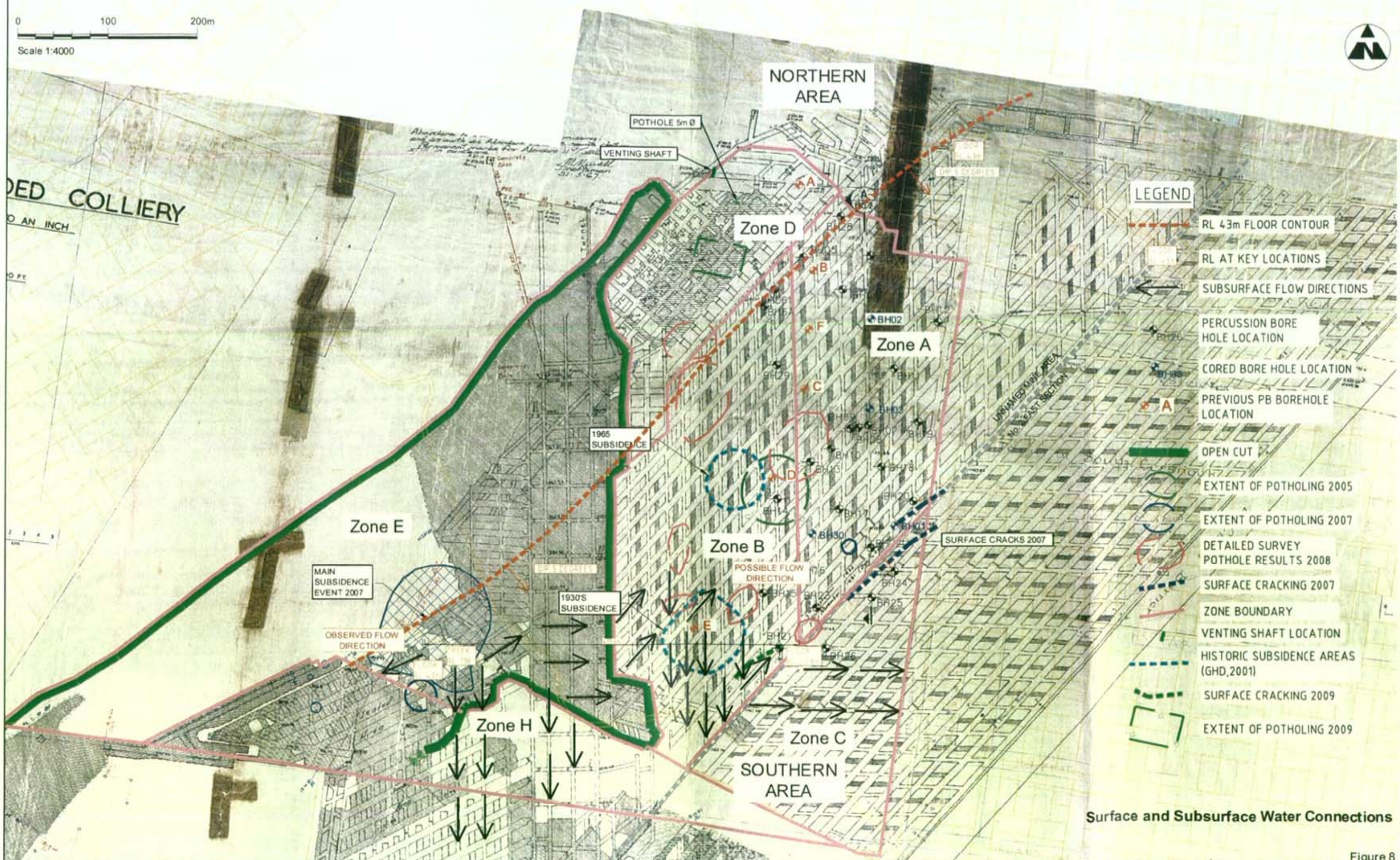
Client: Hunter Land
Project: Cessnock Civic Centre Zone A Geotechnical Investigation
Location: Vincent Street, Cessnock



Subsurface Subsidence Features

Figure 7

Client: Hunter Land
Project: Cessnock Civic Centre Zone A Geotechnical Investigation
Location: Vincent Street, Cessnock



Surface and Subsurface Water Connections

Figure 8

Client: Hunter Land
Project: Cessnock Civic Centre Zone A Geotechnical Investigation
Location: Vincent Street, Cessnock

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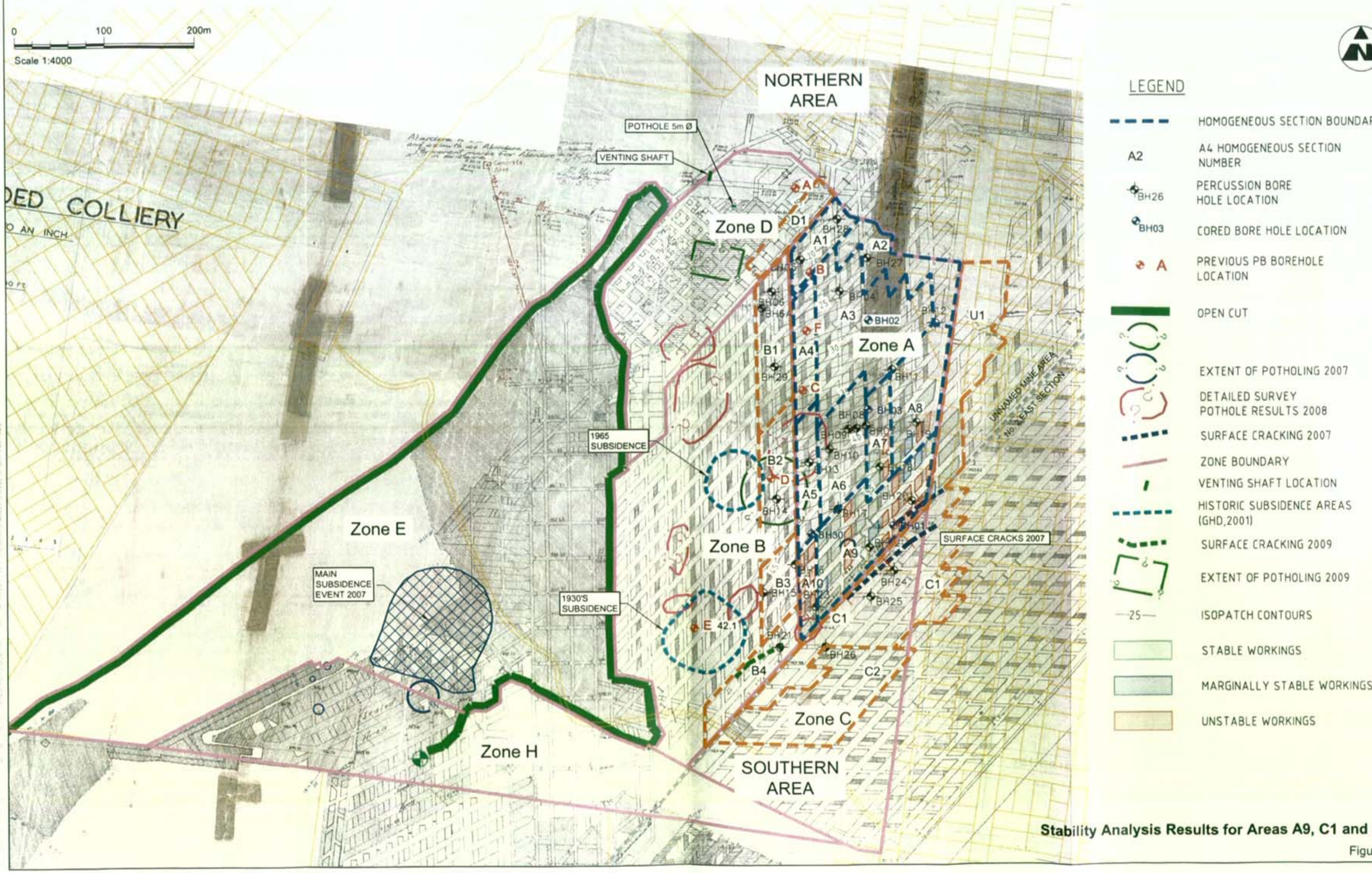
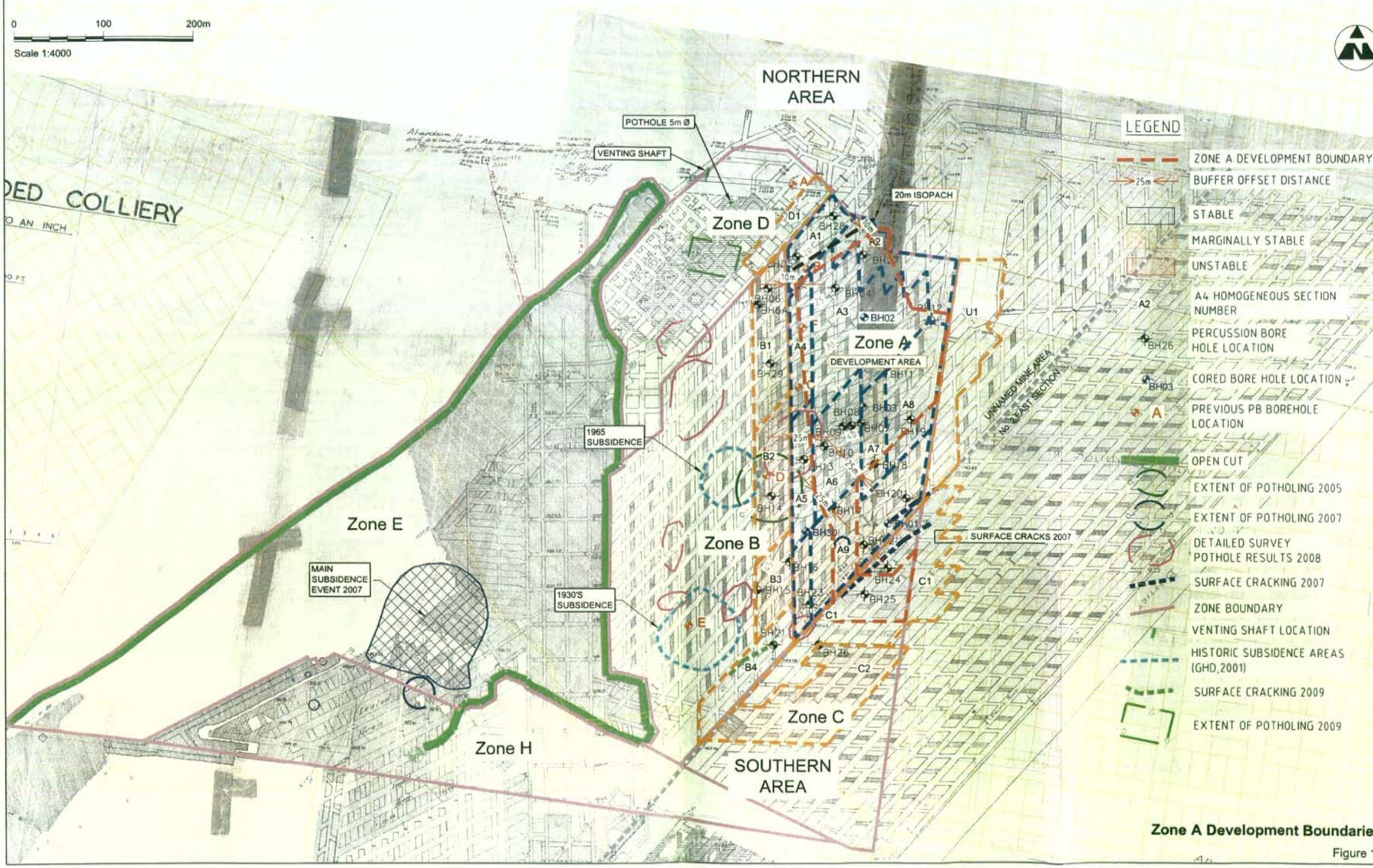


Stability Analysis Results for Areas A9, C1 and C

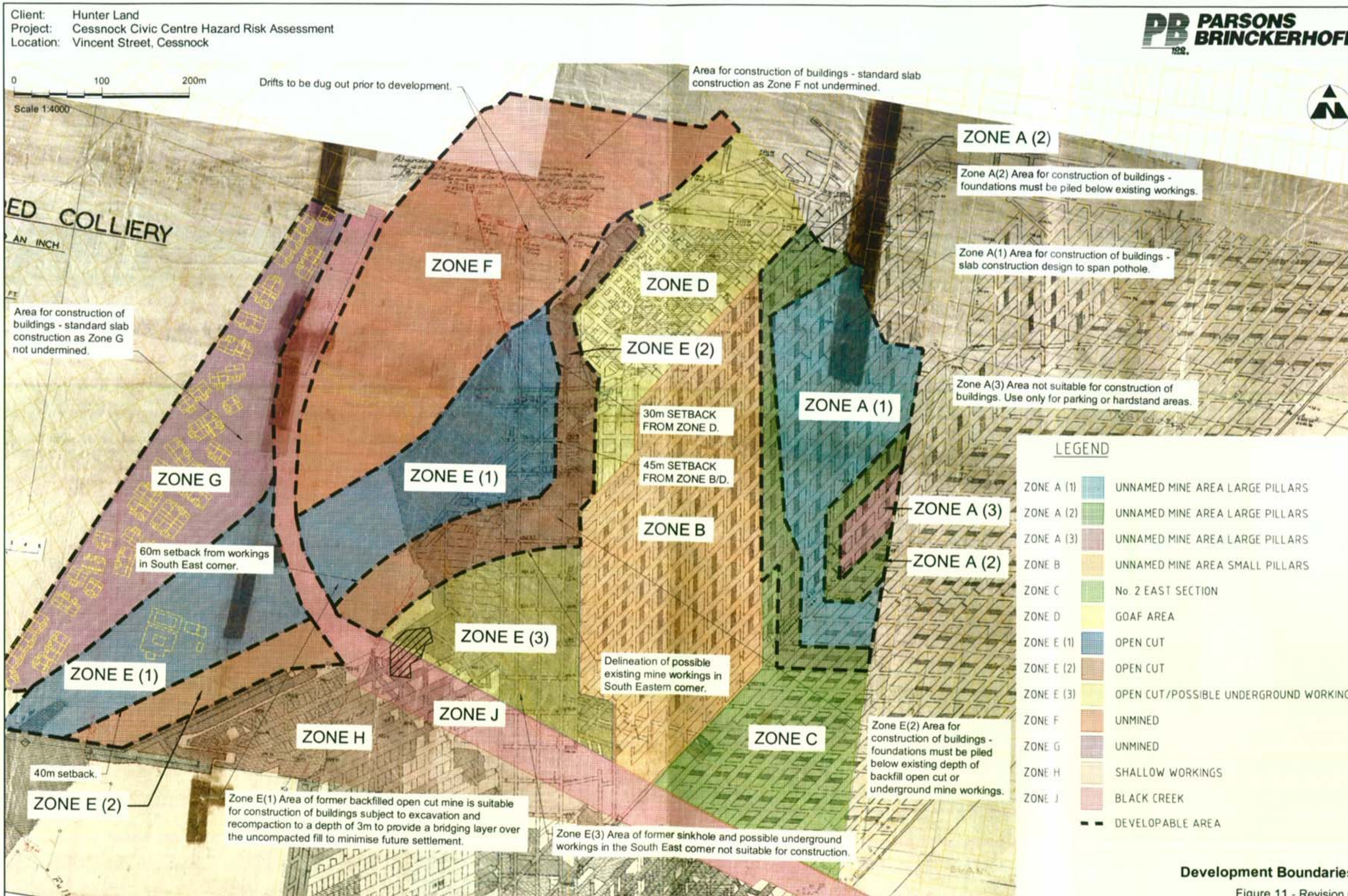
Figure

Client: Hunter Land
Project: Cessnock Civic Centre Zone A Geotechnical Investigation
Location: Vincent Street, Cessnock



Zone A Development Boundarie

Figure



Development Boundarie

Figure 11 - Revision

Client: Hunter Land
Project: Cessnock Civic Centre Hazard Risk Assessment
Location: Vincent Street, Cessnock

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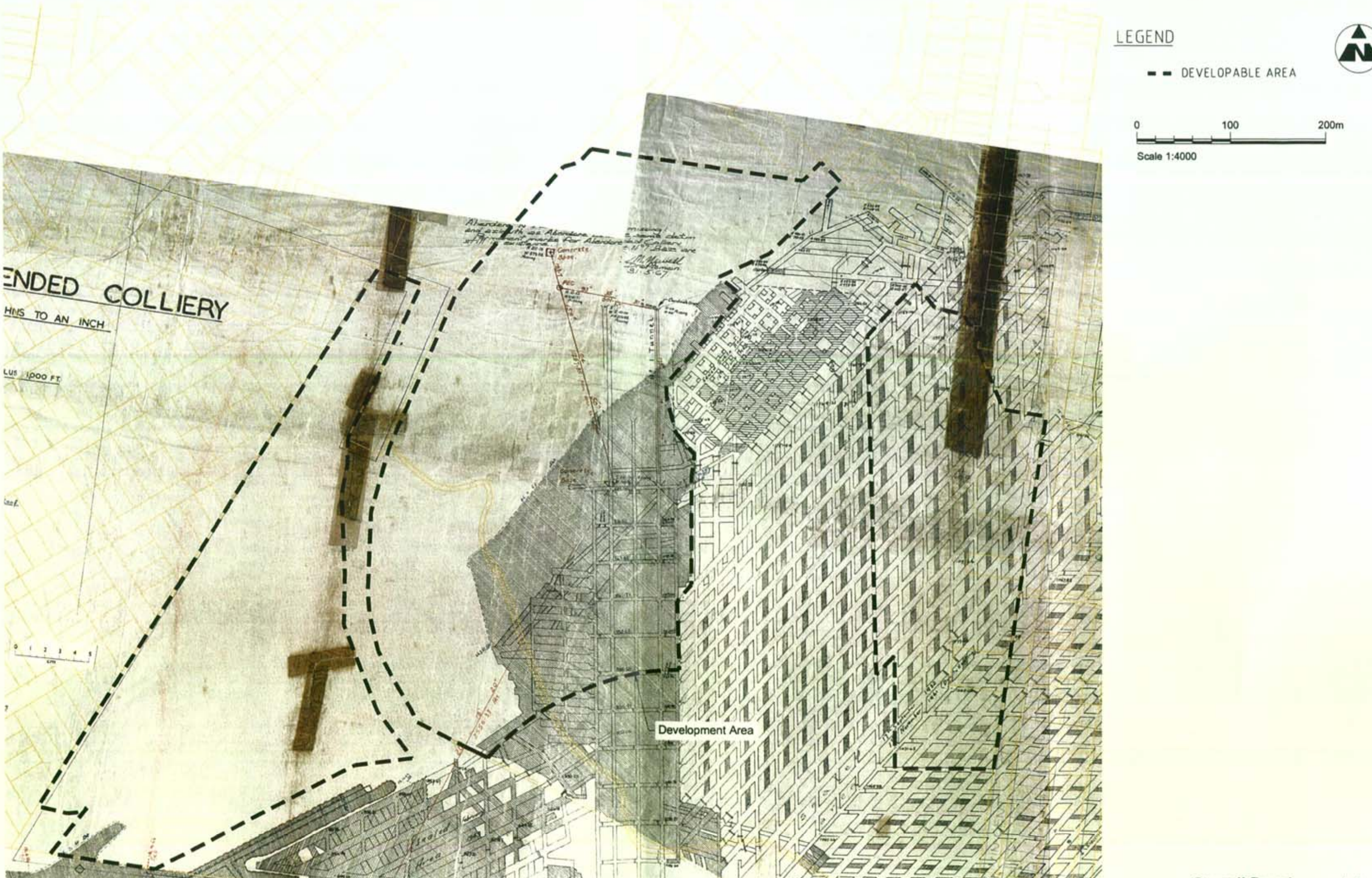

Overall Development Area

Figure 1

Appendix A

Point load strength test reports

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Point Load Strength Index Test Results

CLIENT	Hunter Land/ Regional Land	OFFICE	Newcastle
PROJECT	Vincent Street, Cessnock mine subsidence assessment	DATE	9/9/2009
LOCATION		BY	AJS
JOB NO	2122827B	CHECKED	
TEST METHOD	AS 4133.4.1 - 2007 Methods of Testing Rocks for Engineering Purposes, Determination of Point Load Strength Index	SAMPLING TECHNIQUE	
		STORAGE HISTORY	
TEST MACHINE	GSA-6500	MOISTURE CONDITION	
CALIBRATION DATE	10/6/2008	LOADING RATE	< 30 seconds
SAMPLING DATE	variable	TESTING DATE	9/9/2009
TESTED BY	AJS		

Rock Type	Location	Depth	Diametral Tests					Axial, Block and Irregular Lump Tests							Strength Classification
		(m)	D (mm)	L (mm)	P (kN)	$I_{s(50)}$ (MPa)	Failure Mode	W (mm)	D (mm)	L (mm)	P (kN)	I_s (MPa)	$I_{s(50)}$ (MPa)	Failure Mode	
	BH03	41.44	53	48	0	0	Through substance	53	52	48	2.48	0.71	0.76	Through substance	EL / M
	BH03	9.05	62	43	5.45	1.56	Through substance	62	61	43	3.86	0.8	0.93	Through substance	M / H
	BH03	10.95	62	45	5.76	1.65	Through substance	62	61	45	5.73	1.19	1.38	Through substance	H
	BH03	12.05	62	48	6.75	1.94	Through substance	62	61	48	5.79	1.2	1.39	Through substance	H
	BH03	25.05	63	49	5.07	1.42	Through substance	63	62	49	4.98	1	1.17	Through substance	H
	BH03	26.05	63	58	5.15	1.44	Through substance	63	62	58	5.96	1.2	1.4	Through substance	H
	BH03	28.85	63	55	1.11	0.31	Parallel to bedding	63	62	55	2.2	0.44	0.52	Through substance	M
	BH02	22.01	62	48	6.67	1.91	Through substance	62	61	48	8.29	1.72	2	Through substance	H
	BH02	24.18	62	58	2.09	0.6	Through substance	62	61	58	3.05	0.63	0.73	Through substance	M
	BH02	25.98	62	56	4.21	1.21	Bad break								H
	BH03	21.03	63	40	5.34	1.49	Bad break								H
	BH03	23.05	63	56	11.31	3.16	Through substance	63	62	56	8.24	1.66	1.93	Through substance	H / VH
	BH03	24.05	62	48	6.06	1.74	Through substance	62	61	48	7.35	1.53	1.77	Through substance	H
	BH01	48.05	62	55	2.7	0.77	Through substance	62	61	55	4.54	0.94	1.09	Through substance	M / H
	BH01	1.13					Bad break	52	49	-	3.79	1.17	1.24	Through substance	H
	BH02	29.06	40	48	1.87	1.05	Through substance	48	38	40	1.24	0.53	0.52	Through substance	M / H
	BH02	26.05	63	39	1.69	0.47	Through substance	63	62	39	4.12	0.83	0.97	Through substance	M
	BH02	27.42	62	53	1.07	0.31	Through substance	62	61	53	2.07	0.43	0.5	Through substance	M
	BH30	53.35	62	55	1.47	0.42	Bad break								M
	BH30	25.10	62	42	6.33	1.82	Through substance	62	61	42	4.84	1	1.16	Through substance	H
	BH30	26.05	62	43	6.5	1.86	Through substance	62	61	43	5.24	1.09	1.26	Through substance	H
	BH30	27.94	62	51	5.2	1.49	Through substance	62	61	51	3.86	0.8	0.93	Through substance	M / H
	BH30	28.65	62	46	5.05	1.45	Through substance	62	61	46	5.74	1.19	1.38	Through substance	H
	BH30	37.14	62	53	1.02	0.29	Parallel to bedding	62	61	53	5.66	1.17	1.36	Through substance	L / H
	BH30	39.90	62	43	3.7	1.06	Through substance	62	61	43	6.97	1.45	1.68	Through substance	H
	BH30	39.56	62	51	4.44	1.27	Through substance	62	61	51	3.86	0.8	0.93	Through substance	M / H

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Point Load Strength Index Test Results

CLIENT	Hunter Land/ Regional Land	OFFICE	Newcastle
PROJECT	Vincent Street, Cessnock mine subsidence assessment	DATE	9/9/2009
LOCATION		BY	AJS
JOB NO	2122827B	CHECKED	
TEST METHOD	AS 4133.4.1 - 2007 Methods of Testing Rocks for Engineering Purposes, Determination of Point Load Strength Index	SAMPLING TECHNIQUE	
		STORAGE HISTORY	
TEST MACHINE	GSA-6500	MOISTURE CONDITION	
CALIBRATION DATE	10/6/2008	LOADING RATE	< 30 seconds
		SAMPLING DATE	variable
		TESTING DATE	9/9/2009
		TESTED BY	AJS

Rock Type	Location	Depth (m)	Diametral Tests D (mm)	Diametral L (mm)	Diametral P (kN)	Diametral $I_{s(50)}$ (MPa)	Diametral Failure Mode	Axial, Block, and Irregular Lump Tests W (mm)	D (mm)	L (mm)	P (kN)	I_s (MPa)	$I_{s(50)}$ (MPa)	Failure Mode	Strength Classification
	BH30	40.75	62	44	3.28	0.94	Through substance	62	61	44	6.2	1.29	1.49	Through substance	M / H
	BH30	9.94	62	45	4.83	1.38	Through substance	62	61	45	5.49	1.14	1.32	Through substance	H
	BH30	10.04	62	40	5.82	1.67	Through substance	62	61	40	4.96	1.03	1.19	Through substance	H
	BH30	11.20	62	41	4.93	1.41	Through substance	62	61	41	5.67	1.18	1.36	Through substance	H
	BH30	12.55	62	51	4.52	1.3	Through substance	62	61	51	5.79	1.2	1.39	Through substance	H
	BH30	13.87	62	45	4.82	1.38	Through substance	62	61	45	1.92	0.4	0.46	Through substance	M / H
	BH30	14.26	62	51	4.4	1.26	Through substance	62	61	51	4.77	0.99	1.15	Through substance	H
	BH30	16.10	62	52	6.74	1.93	Through substance	62	61	52	5.46	1.13	1.31	Through substance	H
	BH30	16.56	62	51	3.72	1.07	Along defect	62	61	51	4.91	1.02	1.18	Through substance	H
	BH30	5.95	62	49	3.02	0.87	Through substance	62	61	49	3.82	0.79	0.92	Through substance	M
	BH30	6.95	62	44	4.82	1.38	Along defect	62	61	44	2.74	0.57	0.66	Along defect	M / H
	BH30	8.05	62	52	5.87	1.68	Through substance	62	61	52	5.35	1.11	1.29	Through substance	H
	BH30	3.06	62	44	2.62	0.75	Through substance	62	61	44	2.82	0.59	0.68	Through substance	M
	BH30	3.95	62	40	3.1	0.89	Through substance	62	61	40	2.09	0.44	0.5	Through substance	M
	BH30	4.80	62	50	7.03	2.02	Through substance	62	61	50	4.41	0.92	1.06	Through substance	H
	BH01	8.95	62	60	9.01	2.58	Through substance	62	61	60	0.68	0.14	0.16	Through substance	L / H
	BH01	8.95	62	60	9.01	2.58	Along defect	62	61	60	6.41	1.33	1.54	Along defect	H
	BH01	9.85	62	40	16.54	4.74	Through substance	62	61	40	14.28	2.96	3.44	Through substance	VH
	BH01	10.85	62	42	3.98	1.14	Through substance	62	61	42	5.79	1.2	1.39	Through substance	H
	BH01	11.80	61	44	5.79	1.7	Bad break								H
	BH01	11.85	62	41	5.45	1.56	Through substance	62	61	41	5.46	1.13	1.31	Through substance	H
	BH03	1.60	61	42	2.39	0.7	Through substance	62	61	42	1.5	0.31	0.36	Through substance	M
	BH03	2.95	62	58	4.8	1.38	Through substance	62	61	58	6.94	1.44	1.67	Through substance	H
	BH03	4.05	61	49	3.13	0.92	Through substance	62	61	49	3.72	0.77	0.9	Through substance	M
	BH03	37.50	61	43	1.69	0.5	Through substance	62	61	43	3.05	0.63	0.73	Through substance	M
	BH03	38.20						64	40	64	2.71	0.83	0.88	Along defect	M

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Point Load Strength Index Test Results

Sheet 3 of 3

CLIENT	Hunter Land/ Regional Land	OFFICE	Newcastle
PROJECT	Vincent Street, Cessnock mine subsidence assessment	DATE	9/9/2009
LOCATION		BY	AJS
JOB NO	2122827B	CHECKED	
TEST METHOD	AS 4133.4.1 - 2007 Methods of Testing Rocks for Engineering Purposes, Determination of Point Load Strength Index	SAMPLING TECHNIQUE	
		STORAGE HISTORY	
TEST MACHINE	GSA-6500	MOISTURE CONDITION	
CALIBRATION DATE	10/6/2008	LOADING RATE	< 30 seconds
SAMPLING DATE	variable	TESTING DATE	9/9/2009
TESTED BY	AJS		

Rock Type	Location	Depth (m)	Diametral Tests D (mm)	L (mm)	P (kN)	$I_{s(50)}$ (MPa)	Failure Mode	Axial, Block, and Irregular Lump Tests W (mm)	D (mm)	L (mm)	P (kN)	I_s (MPa)	$I_{s(50)}$ (MPa)	Failure Mode	Strength Classification
	BH03	40.15						60	39	39	1.55	0.52	0.54	Along defect	M
	BH03	17.65	61	62	0.26	0.08	Parallel to bedding	62	61	61	3.75	0.78	0.9	Through substance	VL / M
	BH03	19.05	62	61	3.79	1.09	Through substance								H
	BH03	20.50	61	60	4.12	1.21	Through substance	61	60	60	5.07	1.09	1.25	Through substance	H
	BH03	5.05	61	56	6.07	1.78	Through substance	61	56	56	3.21	0.74	0.84	Through substance	M / H
	BH03	5.25	62	61	3.3	0.95	Through substance	62	61	61	3.78	0.79	0.91	Through substance	M
	BH03	7.10	62	61	6.38	1.83	Through substance	62	61	61	6.39	1.33	1.54	Through substance	H
	BH03	8.94	61	58	5.51	1.62	Through substance	61	58	61	6.81	1.51	1.73	Through substance	H
	BH03	13.05	61	44	4.93	1.45	Through substance	61	44	44	7.21	2.11	2.26	Through substance	H
	BH03	15.05	61	45	5.52	1.62	Through substance	61	45	45	5.07	1.45	1.56	Through substance	H
	BH03	16.05	62	49	3.13	0.9	Through substance	62	49	49	4.15	1.07	1.18	Through substance	M / H
	BH03	33.05	61	51	0.82	0.24	Through substance	61	51	51	6.94	1.75	1.94	Along defect	L / H
	BH03	34.65	61	49	2.91	0.86	Through substance	61	49	49	6.66	1.75	1.92	Through substance	M / H
	BH03	36.16	61	53	3.65	1.07	Through substance	61	53	53	5.23	1.27	1.42	Through substance	H
	BH03	29.25	61	52	3.86	1.13	Through substance	61	52	52	2.46	0.61	0.68	Along defect	M / H
	BH03	31.07	61	50	5.09	1.5	Through substance	61	50	50	5.2	1.34	1.48	Through substance	H
	BH03	32.65	61	50	3.86	1.13	Through substance	61	50	50	2.04	0.52	0.58	Through substance	M / H
	BH02	32.36	61	45	3.82	1.12	Through substance	61	45	45	1.38	0.39	0.42	Through substance	M / H
	BH02	33.83						61	59	45	2.26	0.49	0.57	Along defect	M
	BH02	6.06	61	60	3.44	1.01	Through substance								H
	BH02	6.55	61	52	1.45	0.43	Through substance	61	52	52	1.42	0.35	0.39	Through substance	M
	BH02	7.05	61	54	2.46	0.72	Through substance	61	54	54	2.65	0.63	0.71	Through substance	M
	BH02	8.89	61	52	2.87	0.84	Through substance	61	52	52	2.57	0.64	0.71	Through substance	M
	BH02	9.18	61	54	2.19	0.65	Through substance	61	54	54	2.39	0.57	0.64	Through substance	M
	BH02	10.70	61	46	1.96	0.57	Through substance	61	46	46	2.28	0.64	0.69	Through substance	M

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Appendix B

Laboratory test reports

AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
24 Bermill Street, Rockdale, NSW, 2216 P.O. Box 2014, Rockdale D.C. NSW 2216
Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

POINT LOAD STRENGTH INDEX TEST REPORT

CLIENT: Parsons Brinckerhoff
PO BOX 1162

PROJECT: 2122827B

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION DIAM (mm)	PLATEN SEPARATION HEIGHT (mm)	TEST ORIENTATION	POINT LOAD STRENGTH Is (MPa)	POINT LOAD STRENGTH Is (50) (MPa)
54393	BH01		52.42		Diametral	1.01	1.03
				52.7	Axial	1.04	1.12

NOTES TO TESTING

Testing Device:	ELE Point Load Tester
Sample History:	Unsoaked
Sampled by:	Client
Job Number:	066-122-2
Date Tested:	18.09.09
Test method:	AS 4133.4.1 2007

Form R04 File C:\Excel Reports\Point Load Strength Index Issue 4 September 2001 CWS

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Signed: .... Name: C. Lloyd
Title: LM Date: 22/9/09

AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
24 Bermill Street, Rockdale, NSW, 2216 P.O. Box 2014, Rockdale D.C. NSW 2216
Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.3 - 1993

Client: Parsons Brinckerhoff	**Report No.:** 54262
Project: 212287B	**Test Date:** 04.09.09 **Report Date:** 08.09.09
Bore Hole No: BH 30	**Depth (m):** 54.5-54.70m
Rock Description: Coal	**Sample Type:** Core

Uniaxial Compressive Strength : 15.6 MPa

	Young's Modulus	***Poisson Ratio***	
Secant :	***2.7 GPa***	***0.172***	***Calculated between 0 and 50 % of max. axial stress.***

Axial Stress v's Strain Plots

Remarks: Refer to page 3 for deviations from standards
The duration of the test falls outside the test method limits of 5-15 mins.

Sample/s supplied by the client	Note: Graph not to scale	Page 1 of 3

NATA
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Signed: [signature] Name: C. Lloyd
Title: LM Date: 9/9/09

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.3 - 1993

Client: Parsons Brinckerhoff	**Report No.:** 54262
Project: 212287B	**Test Date:** 04.09.09 **Report Date:** 08.09.09
Bore Hole No: BH 30	**Depth (m):** 54.5-54.70m
Rock Description: Coal	**Sample Type:** Core

Uniaxial Compressive Strength : 15.6 MPa

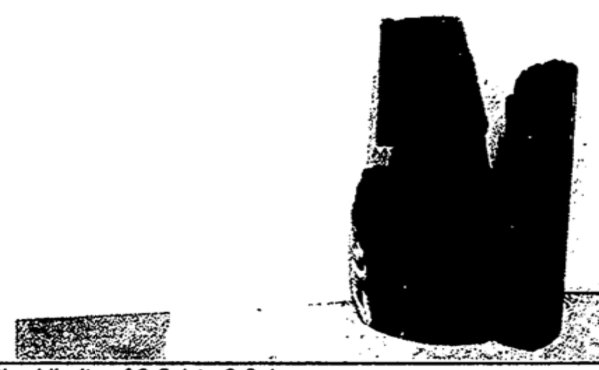
Average Sample Diameter (mm):	61.1	Dry Density (t/m3): 1.22
Sample Height (mm):	142.8	
Duration of Test (min):	2.63	
Rate of Loading (MPa/min):	5.93	
Mode of Failure:	Brittle	

PB
2122827B
Unconfined Compressive Strength
Test Sample

BH 30
54.5-54.70m

PB
2122827B
Unconfined Compressive Strength
After Test Sample

BH 30
54.5-54.70m



Remarks: The length to diameter ratio falls outside the test method limits of 2.5:1 to 3.0:1.
Wet Density (t/m3): 1.26 Moisture Content (%): 3.06

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.3 - 1993

COMPRESSIVE STRENGTH TESTS WITH MODULUS DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.3-1993. Methods of Testing Rocks for Engineering purposes. Method 4.3 - Rock Strength Tests - Determination of deformability of rock materials in uniaxial compression.

SAMPLE PREPARATION AND TESTING PROCEDURE

4(a)(i) Length to diameter ratio may not conform to 2.5 due to the length of suitable sample available. The diameter of the specimen may not be ten times the size of the largest grain in the rock.

4(a)(ii) Ends of the specimen may not be parallel to within 0.05mm in 50mm due to the end preparation technique.

4(a)(iii) Ends of the specimen may not be flat to 0.02mm due to irregularities within the sample, such as solution cavities.

4(a)(iv) The sides of the specimen may not be smooth, free of abrupt irregularities and straight to within 0.3mm over the full length of the specimen. This is due to the drilling process and irregularities within the sample, such as solution cavities.

4(c) Samples were tested in the "As Received" condition. They were not conditioned in a uniform temperate and humidified environment for five or more days.

5(a) Specimens were loaded at a constant rate of load to achieve failure within 5 to 15 minutes of loading. The rate of loading was based on an initial estimate of the UCS strength. However in some cases, failure occurred before 5 minutes loading, due to lower than estimated strength.

7(i) Prior to testing, the cores were stored as received from site. ie the cores were wrapped in plastic

TEST EQUIPMENT

Test Equipment: ELE Compact 1000 Hydraulic Compression Test Machine.

AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
24 Bermill Street, Rockdale, NSW, 2216 P.O. Box 2014, Rockdale D.C NSW 2216
Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

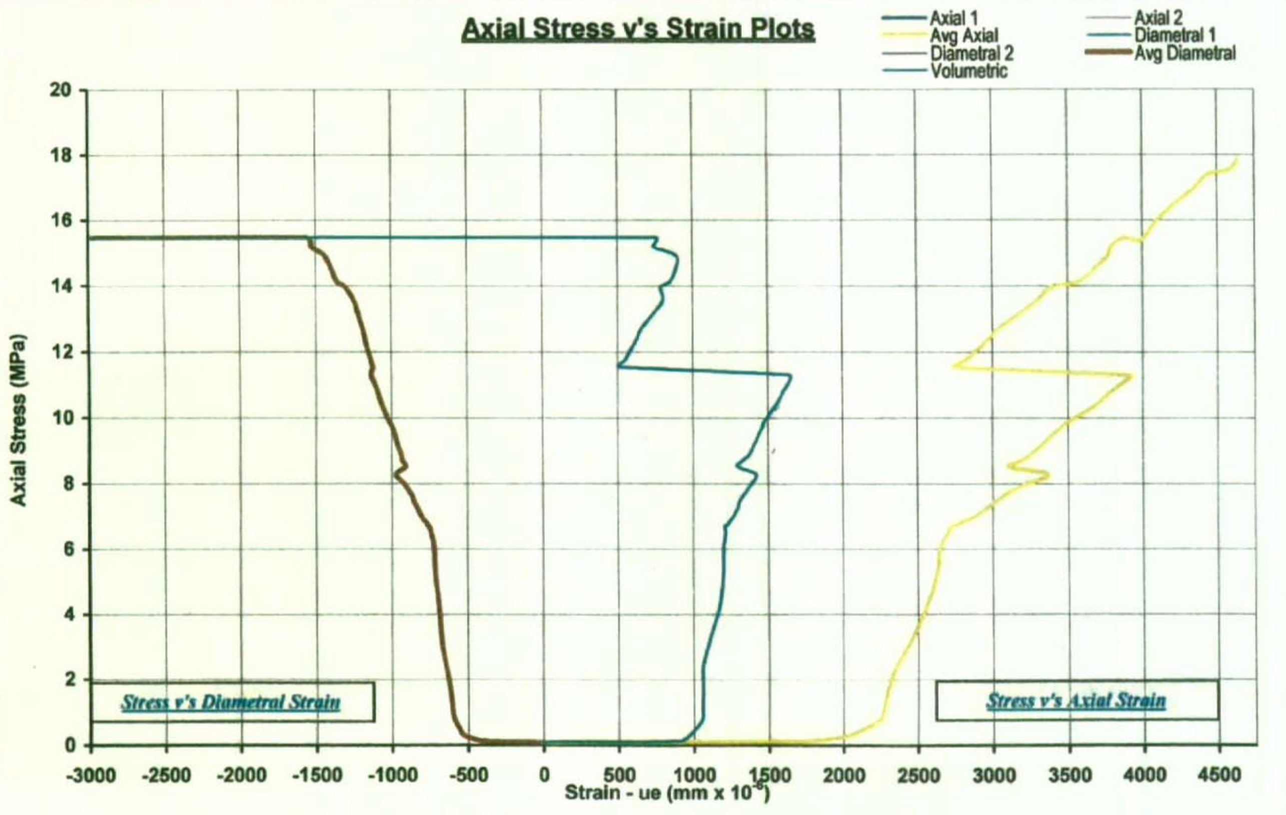
UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.3 - 1993

Client: Parsons Brinckerhoff	**Report No.:** 54263
Project: 2122827B	**Test Date:** 04.09.09 **Report Date:** 08.09.09
Bore Hole No: CBH03	**Depth (m):** 41.6-41.86m
Rock Description: Coal	**Sample Type:** Core

Uniaxial Compressive Strength : ***17.9*** ***MPa***

	Young's Modulus	**Poisson Ratio**	
Secant :	***2.7 GPa***	***0.286***	***Calculated between 0 and 50 % of max. axial stress.***



Remarks: Refer to page 3 for deviations from standards
The duration of the test falls outside the test method limits of 5-15 mins.

Sample/s supplied by the client	Note: Graph not to scale	Page 1 of 3

NATA
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Signed: [signature] Name: C. Lloyd
Title: Lm Date: 9/9/09

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.3 - 1993

Client: Parsons Brinckerhoff	**Report No.:** 54263
Project: 2122827B	**Test Date:** 04.09.09 **Report Date:** 08.09.09
Bore Hole No: CBH03	**Depth (m):** 41.6-41.86m
Rock Description: Coal	**Sample Type:** Core

Uniaxial Compressive Strength : 17.9 MPa

Average Sample Diameter (mm):	61.3	Dry Density (t/m3): 1.20
Sample Height (mm):	137.3	
Duration of Test (min):	2.30	
Rate of Loading (MPa/min):	7.76	
Mode of Failure:	Brittle	

Remarks: The length to diameter ratio falls outside the test method limits of 2.5:1 to 3.0:1.
Wet Density (t/m3): 1.23 Moisture Content (%): 2.54

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.3 - 1993

COMPRESSIVE STRENGTH TESTS WITH MODULUS DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.3-1993. Methods of Testing Rocks for Engineering purposes. Method 4.3 - Rock Strength Tests - Determination of deformability of rock materials in uniaxial compression.

SAMPLE PREPARATION AND TESTING PROCEDURE

4(a)(i) Length to diameter ratio may not conform to 2.5 due to the length of suitable sample available. The diameter of the specimen may not be ten times the size of the largest grain in the rock.

4(a)(ii) Ends of the specimen may not be parallel to within 0.05mm in 50mm due to the end preparation technique.

4(a)(iii) Ends of the specimen may not be flat to 0.02mm due to irregularities within the sample, such as solution cavities.

4(a)(iv) The sides of the specimen may not be smooth, free of abrupt irregularities and straight to within 0.3mm over the full length of the specimen. This is due to the drilling process and irregularities within the sample, such as solution cavities.

4(c) Samples were tested in the "As Received" condition. They were not conditioned in a uniform temperate and humidified environment for five or more days.

5(a) Specimens were loaded at a constant rate of load to achieve failure within 5 to 15 minutes of loading. The rate of loading was based on an initial estimate of the UCS strength. However in some cases, failure occurred before 5 minutes loading, due to lower than estimated strength.

7(i) Prior to testing, the cores were stored as received from site. ie the cores were wrapped in plastic

TEST EQUIPMENT

Test Equipment: ELE Compact 1000 Hydraulic Compression Test Machine.

Appendix C

Pillar stability analysis output

Parsons Brinckerhoff

ABN 84797323433

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

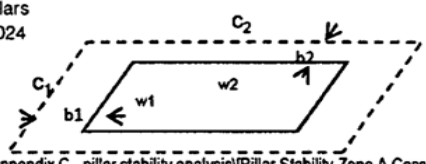
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A1**	**Area A1**	**Area A1**
Depth of Workings H (m)	19	19	19
Pillar Width w1 (m)	8.5	8.5	8.5
Pillar Length w2 (m)	17.6	17.6	17.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.24**	**1.72**	**1.39**
Tributary Area c1 (m)	13.40	13.40	13.40
Tributary Area c2 (m)	24.90	24.90	24.90
Vertical Stress Sv (MPa)	0.47	0.47	0.47
Bieniawski Strength (MPa)	6.08	5.30	4.81
Salamon & Munro Strength (MPa)	7.86	6.60	5.75
UNSW Strength (MPa) **w/h<5**	8.21	6.89	6.00
UNSW Strength (MPa) **w/h>5**	10.51	10.13	9.90
Pillar Load* - Obert & Duval (MPa)	1.04	1.04	1.04
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	5.9	5.1	4.6
S & M Factor of Safety	7.6	6.4	5.5
UNSW Factor of Safety (Power Law)	7.9	6.6	5.8
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

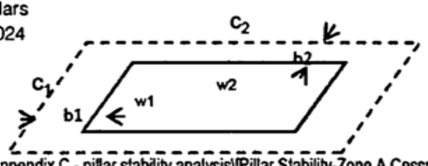
		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A2**	**Area A2**	**Area A2**
Depth of Workings H (m)	26	26	26
Pillar Width w1 (m)	14.3	14.3	14.3
Pillar Length w2 (m)	24.1	24.1	24.1
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.3	4.3	4.3
Pillar width/height w/h	**3.76**	**2.89**	**2.34**
Tributary Area c1 (m)	18.60	18.60	18.60
Tributary Area c2 (m)	31.40	31.40	31.40
Vertical Stress Sv (MPa)	0.64	0.64	0.64
Bieniawski Strength (MPa)	8.36	7.05	6.24
Salamon & Munro Strength (MPa)	9.99	8.39	7.31
UNSW Strength (MPa) **w/h<5**	10.42	8.75	7.63
UNSW Strength (MPa) **w/h>5**	10.85	9.98	9.55
Pillar Load* - Obert & Duval (MPa)	1.08	1.08	1.08
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	7.7	6.5	5.8
S & M Factor of Safety	9.3	7.8	6.8
UNSW Factor of Safety (Power Law)	9.7	8.1	7.1
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

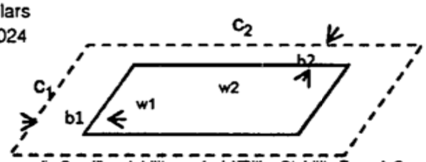
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A3-1**	**Area A3-1**	**Area A3-1**
Depth of Workings H (m)	30	30	30
Pillar Width w1 (m)	9.3	9.3	9.3
Pillar Length w2 (m)	18.9	18.9	18.9
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.45**	**1.88**	**1.52**
Tributary Area c1 (m)	14.20	14.20	14.20
Tributary Area c2 (m)	26.20	26.20	26.20
Vertical Stress Sv (MPa)	0.74	0.74	0.74
Bieniawski Strength (MPa)	6.39	5.54	5.01
Salamon & Munro Strength (MPa)	8.19	6.88	6.00
UNSW Strength (MPa) **w/h<5**	8.55	7.18	6.26
UNSW Strength (MPa) **w/h>5**	10.49	10.06	9.81
Pillar Load* - Obert & Duval (MPa)	1.56	1.56	1.56
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	4.1	3.6	3.2
S & M Factor of Safety	5.3	4.4	3.9
UNSW Factor of Safety (Power Law)	5.5	4.6	4.0
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

Job Number	2122827B	Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

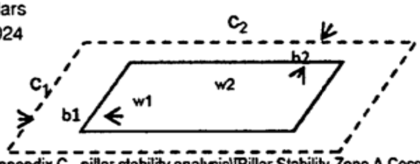
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A3-2**	**Area A3-2**	**Area A3-2**
Depth of Workings H (m)	35	35	35
Pillar Width w1 (m)	6.9	6.9	6.9
Pillar Length w2 (m)	18.6	18.6	18.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.82**	**1.39**	**1.13**
Tributary Area c1 (m)	11.80	11.80	11.80
Tributary Area c2 (m)	25.90	25.90	25.90
Vertical Stress Sv (MPa)	0.86	0.86	0.86
Bieniawski Strength (MPa)	5.44	4.81	4.42
Salamon & Munro Strength (MPa)	7.14	6.00	5.23
UNSW Strength (MPa) **w/h<5**	7.45	6.26	5.45
UNSW Strength (MPa) **w/h>5**	10.63	10.32	10.13
Pillar Load* - Obert & Duval (MPa)	2.04	2.04	2.04
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.7	2.4	2.2
S & M Factor of Safety	3.5	2.9	2.6
UNSW Factor of Safety (Power Law)	3.7	3.1	2.7
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

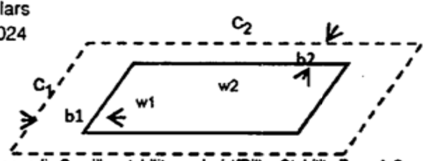
		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A4**	**Area A4**	**Area A4**
Depth of Workings H (m)	34	34	34
Pillar Width w1 (m)	10.1	10.1	10.1
Pillar Length w2 (m)	19.8	19.8	19.8
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.66**	**2.04**	**1.66**
Tributary Area c1 (m)	15.00	15.00	15.00
Tributary Area c2 (m)	27.10	27.10	27.10
Vertical Stress Sv (MPa)	0.83	0.83	0.83
Bieniawski Strength (MPa)	6.71	5.78	5.20
Salamon & Munro Strength (MPa)	8.51	7.15	6.23
UNSW Strength (MPa) **w/h<5**	8.88	7.46	6.50
UNSW Strength (MPa) **w/h>5**	10.49	10.01	9.74
Pillar Load* - Obert & Duval (MPa)	1.69	1.69	1.69
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	4.0	3.4	3.1
S & M Factor of Safety	5.0	4.2	3.7
UNSW Factor of Safety (Power Law)	5.2	4.4	3.8
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

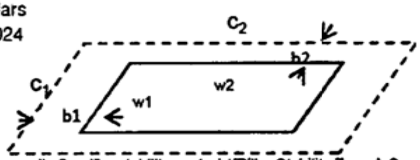
Job Number	2122827B		
Sheet	1 of 1		
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A5**	**Area A5**	**Area A5**
Depth of Workings H (m)	45.5	45.5	45.5
Pillar Width w1 (m)	7.8	7.8	7.8
Pillar Length w2 (m)	18.3	18.3	18.3
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.05**	**1.58**	**1.28**
Tributary Area c1 (m)	12.70	12.70	12.70
Tributary Area c2 (m)	25.60	25.60	25.60
Vertical Stress Sv (MPa)	1.11	1.11	1.11
Bieniawski Strength (MPa)	5.80	5.08	4.64
Salamon & Munro Strength (MPa)	7.56	6.35	5.53
UNSW Strength (MPa) **w/h<5**	7.89	6.62	5.77
UNSW Strength (MPa) **w/h>5**	10.55	10.20	9.99
Pillar Load* - Obert & Duval (MPa)	2.54	2.54	2.54
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.3	2.0	1.8
S & M Factor of Safety	3.0	2.5	2.2
UNSW Factor of Safety (Power Law)	3.1	2.6	2.3
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

Job Number	2122827B	Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

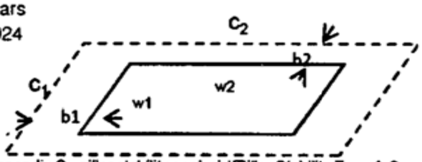
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A6**	**Area A6**	**Area A6**
Depth of Workings H (m)	44	44	44
Pillar Width w1 (m)	7.6	7.6	7.6
Pillar Length w2 (m)	17.1	17.1	17.1
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.00**	**1.54**	**1.25**
Tributary Area c1 (m)	12.50	12.50	12.50
Tributary Area c2 (m)	24.40	24.40	24.40
Vertical Stress Sv (MPa)	1.08	1.08	1.08
Bieniawski Strength (MPa)	5.72	5.02	4.59
Salamon & Munro Strength (MPa)	7.47	6.27	5.46
UNSW Strength (MPa) **w/h<5**	7.79	6.55	5.70
UNSW Strength (MPa) **w/h>5**	10.56	10.23	10.02
Pillar Load* - Obert & Duval (MPa)	2.53	2.53	2.53
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.3	2.0	1.8
S & M Factor of Safety	3.0	2.5	2.2
UNSW Factor of Safety (Power Law)	3.1	2.6	2.3
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

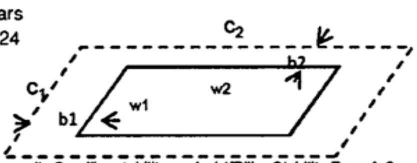
		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A7-1**	**Area A7-1**	**Area A7-1**
Depth of Workings H (m)	40	40	40
Pillar Width w1 (m)	10.7	10.7	10.7
Pillar Length w2 (m)	18.6	18.6	18.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.82**	**2.16**	**1.75**
Tributary Area c1 (m)	15.60	15.60	15.60
Tributary Area c2 (m)	25.90	25.90	25.90
Vertical Stress Sv (MPa)	0.98	0.98	0.98
Bieniawski Strength (MPa)	6.94	5.96	5.35
Salamon & Munro Strength (MPa)	8.74	7.34	6.40
UNSW Strength (MPa) **w/h<5**	9.12	7.66	6.67
UNSW Strength (MPa) **w/h>5**	10.51	9.98	9.70
Pillar Load* - Obert & Duval (MPa)	1.99	1.99	1.99
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	3.5	3.0	2.7
S & M Factor of Safety	4.4	3.7	3.2
UNSW Factor of Safety (Power Law)	4.6	3.9	3.4
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

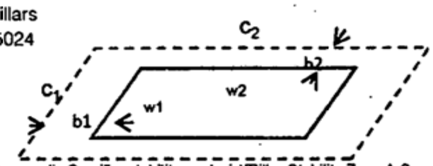
		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A7-2**	**Area A7-2**	**Area A7-2**
Depth of Workings H (m)	44.3	44.3	44.3
Pillar Width w1 (m)	5.8	5.8	5.8
Pillar Length w2 (m)	17.5	17.5	17.5
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.53**	**1.17**	**0.95**
Tributary Area c1 (m)	10.70	10.70	10.70
Tributary Area c2 (m)	24.80	24.80	24.80
Vertical Stress Sv (MPa)	1.09	1.09	1.09
Bieniawski Strength (MPa)	5.01	4.48	4.15
Salamon & Munro Strength (MPa)	6.59	5.54	4.83
UNSW Strength (MPa) **w/h<5**	6.88	5.78	5.04
UNSW Strength (MPa) **w/h>5**	10.79	10.52	10.34
Pillar Load* - Obert & Duval (MPa)	2.84	2.84	2.84
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.8	1.6	1.5
S & M Factor of Safety	2.3	2.0	1.7
UNSW Factor of Safety (Power Law)	2.4	2.0	1.8
RESULT	Stable	Stable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

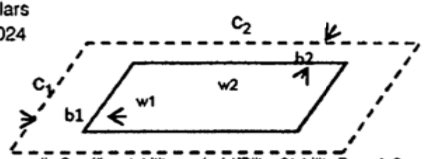
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A8-1**	**Area A8-1**	**Area A8-1**
Depth of Workings H (m)	40	40	40
Pillar Width w1 (m)	9.7	9.7	9.7
Pillar Length w2 (m)	17.3	17.3	17.3
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.55**	**1.96**	**1.59**
Tributary Area c1 (m)	14.60	14.60	14.60
Tributary Area c2 (m)	24.60	24.60	24.60
Vertical Stress Sv (MPa)	0.98	0.98	0.98
Bieniawski Strength (MPa)	6.55	5.66	5.11
Salamon & Munro Strength (MPa)	8.35	7.02	6.11
UNSW Strength (MPa) **w/h<5**	8.72	7.32	6.38
UNSW Strength (MPa) **w/h>5**	10.49	10.03	9.78
Pillar Load* - Obert & Duval (MPa)	2.10	2.10	2.10
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	3.1	2.7	2.4
S & M Factor of Safety	4.0	3.3	2.9
UNSW Factor of Safety (Power Law)	4.2	3.5	3.0
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

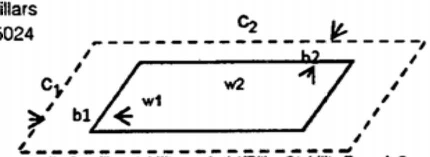
Job Number	2122827B		
Sheet	2 of 2		
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A8-2**	**Area A8-2**	**Area A8-2**
Depth of Workings H (m)	44.3	44.3	44.3
Pillar Width w1 (m)	6.5	6.5	6.5
Pillar Length w2 (m)	17.6	17.6	17.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.71**	**1.31**	**1.07**
Tributary Area c1 (m)	11.40	11.40	11.40
Tributary Area c2 (m)	24.90	24.90	24.90
Vertical Stress Sv (MPa)	1.09	1.09	1.09
Bieniawski Strength (MPa)	5.29	4.69	4.32
Salamon & Munro Strength (MPa)	6.95	5.84	5.08
UNSW Strength (MPa) **w/h<5**	7.25	6.09	5.31
UNSW Strength (MPa) **w/h>5**	10.68	10.39	10.20
Pillar Load* - Obert & Duval (MPa)	2.69	2.69	2.69
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.0	1.7	1.6
S & M Factor of Safety	2.6	2.2	1.9
UNSW Factor of Safety (Power Law)	2.7	2.3	2.0
RESULT	Stable	Stable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

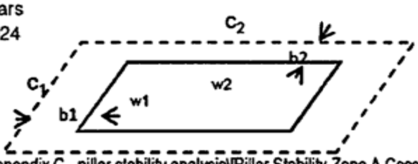
Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-1**	**Area A9-1**	**Area A9-1**
Depth of Workings H (m)	49	49	49
Pillar Width w1 (m)	10.5	10.5	10.5
Pillar Length w2 (m)	14.8	14.8	14.8
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.76**	**2.12**	**1.72**
Tributary Area c1 (m)	15.40	15.40	15.40
Tributary Area c2 (m)	22.10	22.10	22.10
Vertical Stress Sv (MPa)	1.20	1.20	1.20
Bieniawski Strength (MPa)	6.86	5.90	5.30
Salamon & Munro Strength (MPa)	8.66	7.28	6.34
UNSW Strength (MPa) **w/h<5**	9.04	7.60	6.62
UNSW Strength (MPa) **w/h>5**	10.50	9.99	9.71
Pillar Load* - Obert & Duval (MPa)	2.63	2.63	2.63
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.6	2.2	2.0
S & M Factor of Safety	3.3	2.8	2.4
UNSW Factor of Safety (Power Law)	3.4	2.9	2.5
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:
1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

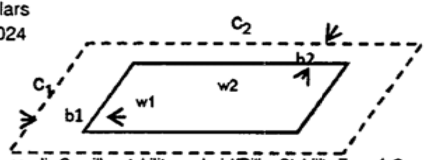
		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-2**	**Area A9-2**	**Area A9-2**
Depth of Workings H (m)	49	49	49
Pillar Width w1 (m)	7.5	7.5	7.5
Pillar Length w2 (m)	13.6	13.6	13.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.97**	**1.52**	**1.23**
Tributary Area c1 (m)	12.40	12.40	12.40
Tributary Area c2 (m)	20.90	20.90	20.90
Vertical Stress Sv (MPa)	1.20	1.20	1.20
Bieniawski Strength (MPa)	5.68	4.99	4.56
Salamon & Munro Strength (MPa)	7.42	6.23	5.43
UNSW Strength (MPa) **w/h<5**	7.75	6.51	5.67
UNSW Strength (MPa) **w/h>5**	10.57	10.24	10.03
Pillar Load* - Obert & Duval (MPa)	3.05	3.05	3.05
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.9	1.6	1.5
S & M Factor of Safety	2.4	2.0	1.8
UNSW Factor of Safety (Power Law)	2.5	2.1	1.9
RESULT	Stable	Stable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

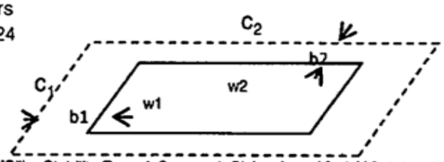
		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	3 December 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-3**	**Area A9-3**	**Area A9-3**
Depth of Workings H (m)	46.5	46.5	46.5
Pillar Width w1 (m)	9.7	9.7	9.7
Pillar Length w2 (m)	17.3	17.3	17.3
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.55**	**1.96**	**1.59**
Tributary Area c1 (m)	14.60	14.60	14.60
Tributary Area c2 (m)	24.60	24.60	24.60
Vertical Stress Sv (MPa)	1.14	1.14	1.14
Bieniawski Strength (MPa)	6.55	5.66	5.11
Salamon & Munro Strength (MPa)	8.35	7.02	6.11
UNSW Strength (MPa) **w/h<5**	8.72	7.32	6.38
UNSW Strength (MPa) **w/h>5**	10.49	10.03	9.78
Pillar Load* - Obert & Duval (MPa)	2.44	2.44	2.44
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.7	2.3	2.1
S & M Factor of Safety	3.4	2.9	2.5
UNSW Factor of Safety (Power Law)	3.6	3.0	2.6
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	3 December 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

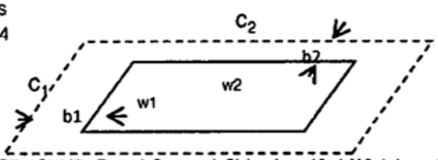
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-4**	**Area A9-4**	**Area A9-4**
Depth of Workings H (m)	45.8	45.8	45.8
Pillar Width w1 (m)	7.4	7.4	7.4
Pillar Length w2 (m)	17.2	17.2	17.2
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.95**	**1.49**	**1.21**
Tributary Area c1 (m)	12.30	12.30	12.30
Tributary Area c2 (m)	24.50	24.50	24.50
Vertical Stress Sv (MPa)	1.12	1.12	1.12
Bieniawski Strength (MPa)	5.64	4.96	4.54
Salamon & Munro Strength (MPa)	7.38	6.20	5.40
UNSW Strength (MPa) **w/h<5**	7.70	6.47	5.63
UNSW Strength (MPa) **w/h>5**	10.58	10.25	10.05
Pillar Load* - Obert & Duval (MPa)	2.66	2.66	2.66
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.1	1.9	1.7
S & M Factor of Safety	2.8	2.3	2.0
UNSW Factor of Safety (Power Law)	2.9	2.4	2.1
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

Job Number	2122827B	Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	3 December 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

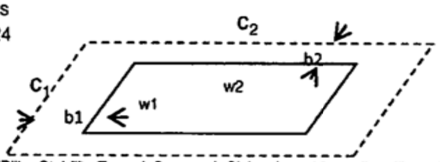
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-1**	**Area A9-1**	**Area A9-1**
Depth of Workings H (m)	49	49	49
Pillar Width w1 (m)	9.5	9.5	9.5
Pillar Length w2 (m)	13.8	13.8	13.8
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**2.50**	**1.92**	**1.56**
Tributary Area c1 (m)	15.40	15.40	15.40
Tributary Area c2 (m)	22.10	22.10	22.10
Vertical Stress Sv (MPa)	1.20	1.20	1.20
Bieniawski Strength (MPa)	6.47	5.60	5.06
Salamon & Munro Strength (MPa)	8.27	6.95	6.05
UNSW Strength (MPa) **w/h<5**	8.64	7.25	6.32
UNSW Strength (MPa) **w/h>5**	10.49	10.05	9.79
Pillar Load* - Obert & Duval (MPa)	3.12	3.12	3.12
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.1	1.8	1.6
S & M Factor of Safety	2.7	2.2	1.9
UNSW Factor of Safety (Power Law)	2.8	2.3	2.0
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

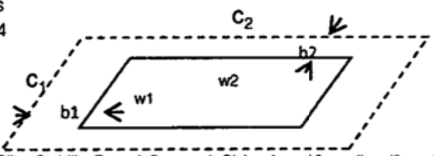
		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	3 December 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-2**	**Area A9-2**	**Area A9-2**
Depth of Workings H (m)	49	49	49
Pillar Width w1 (m)	6.5	6.5	6.5
Pillar Length w2 (m)	12.6	12.6	12.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.71**	**1.31**	**1.07**
Tributary Area c1 (m)	12.40	12.40	12.40
Tributary Area c2 (m)	20.90	20.90	20.90
Vertical Stress Sv (MPa)	1.20	1.20	1.20
Bieniawski Strength (MPa)	5.29	4.69	4.32
Salamon & Munro Strength (MPa)	6.95	5.84	5.08
UNSW Strength (MPa) **w/h<5**	7.25	6.09	5.31
UNSW Strength (MPa) **w/h>5**	10.68	10.39	10.20
Pillar Load* - Obert & Duval (MPa)	3.80	3.80	3.80
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.4	1.2	1.1
S & M Factor of Safety	1.8	1.5	1.3
UNSW Factor of Safety (Power Law)	1.9	1.6	1.4
RESULT	Unstable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



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Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

Job Number	2122827B		
Sheet	1 of 2		
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	3 December 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

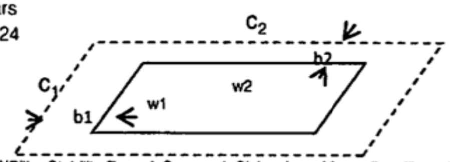
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-3**	**Area A9-3**	**Area A9-3**
Depth of Workings H (m)	46.5	46.5	46.5
Pillar Width w1 (m)	8.7	8.7	8.7
Pillar Length w2 (m)	16.3	16.3	16.3
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**2.29**	**1.76**	**1.43**
Tributary Area c1 (m)	14.60	14.60	14.60
Tributary Area c2 (m)	24.60	24.60	24.60
Vertical Stress Sv (MPa)	1.14	1.14	1.14
Bieniawski Strength (MPa)	6.15	5.36	4.86
Salamon & Munro Strength (MPa)	7.95	6.67	5.81
UNSW Strength (MPa) **w/h<5**	8.29	6.97	6.07
UNSW Strength (MPa) **w/h>5**	10.50	10.11	9.88
Pillar Load* - Obert & Duval (MPa)	2.89	2.89	2.89
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.1	1.9	1.7
S & M Factor of Safety	2.8	2.3	2.0
UNSW Factor of Safety (Power Law)	2.9	2.4	2.1
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	3 December 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

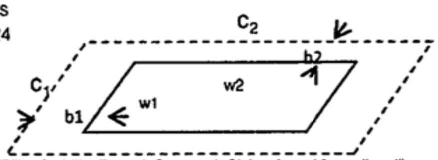
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-4**	**Area A9-4**	**Area A9-4**
Depth of Workings H (m)	45.8	45.8	45.8
Pillar Width w1 (m)	6.4	6.4	6.4
Pillar Length w2 (m)	16.2	16.2	16.2
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.68**	**1.29**	**1.05**
Tributary Area c1 (m)	12.30	12.30	12.30
Tributary Area c2 (m)	24.50	24.50	24.50
Vertical Stress Sv (MPa)	1.12	1.12	1.12
Bieniawski Strength (MPa)	5.25	4.66	4.29
Salamon & Munro Strength (MPa)	6.90	5.79	5.05
UNSW Strength (MPa) **w/h<5**	7.20	6.05	5.27
UNSW Strength (MPa) **w/h>5**	10.69	10.41	10.22
Pillar Load* - Obert & Duval (MPa)	3.26	3.26	3.26
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.6	1.4	1.3
S & M Factor of Safety	2.1	1.8	1.5
UNSW Factor of Safety (Power Law)	2.2	1.9	1.6
RESULT	Stable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

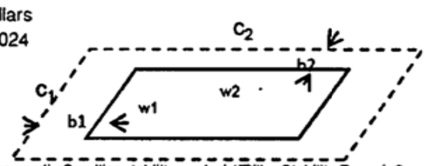
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A10-1**	**Area A10-1**	**Area A10-1**
Depth of Workings H (m)	47.5	47.5	47.5
Pillar Width w1 (m)	6.6	6.6	6.6
Pillar Length w2 (m)	17.6	17.6	17.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.74**	**1.33**	**1.08**
Tributary Area c1 (m)	11.50	11.50	11.50
Tributary Area c2 (m)	24.90	24.90	24.90
Vertical Stress Sv (MPa)	1.16	1.16	1.16
Bieniawski Strength (MPa)	5.33	4.72	4.34
Salamon & Munro Strength (MPa)	7.00	5.88	5.12
UNSW Strength (MPa) **w/h<5**	7.30	6.13	5.34
UNSW Strength (MPa) **w/h>5**	10.67	10.37	10.18
Pillar Load* - Obert & Duval (MPa)	2.87	2.87	2.87
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.9	1.6	1.5
S & M Factor of Safety	2.4	2.0	1.8
UNSW Factor of Safety (Power Law)	2.5	2.1	1.9
RESULT	Stable	Stable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



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ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

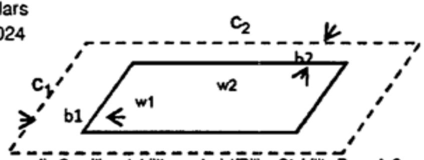
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A10-2**	**Area A10-2**	**Area A10-2**
Depth of Workings H (m)	48.5	48.5	48.5
Pillar Width w1 (m)	5.5	5.5	5.5
Pillar Length w2 (m)	16.3	16.3	16.3
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.45**	**1.11**	**0.90**
Tributary Area c1 (m)	10.40	10.40	10.40
Tributary Area c2 (m)	23.60	23.60	23.60
Vertical Stress Sv (MPa)	1.19	1.19	1.19
Bieniawski Strength (MPa)	4.89	4.39	4.07
Salamon & Munro Strength (MPa)	6.44	5.40	4.71
UNSW Strength (MPa) **w/h<5**	6.72	5.64	4.91
UNSW Strength (MPa) **w/h>5**	10.84	10.58	10.41
Pillar Load* - Obert & Duval (MPa)	3.25	3.25	3.25
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.5	1.3	1.3
S & M Factor of Safety	2.0	1.7	1.4
UNSW Factor of Safety (Power Law)	2.1	1.7	1.5
RESULT	Stable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

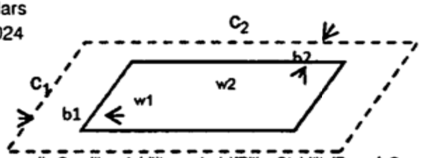
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area B1-1**	**Area B1-1**	**Area B1-1**
Depth of Workings H (m)	29	29	29
Pillar Width w1 (m)	6.9	6.9	6.9
Pillar Length w2 (m)	17.4	17.4	17.4
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.82**	**1.39**	**1.13**
Tributary Area c1 (m)	11.80	11.80	11.80
Tributary Area c2 (m)	24.70	24.70	24.70
Vertical Stress Sv (MPa)	0.71	0.71	0.71
Bieniawski Strength (MPa)	5.44	4.81	4.42
Salamon & Munro Strength (MPa)	7.14	6.00	5.23
UNSW Strength (MPa) **w/h<5**	7.45	6.26	5.45
UNSW Strength (MPa) **w/h>5**	10.63	10.32	10.13
Pillar Load* - Obert & Duval (MPa)	1.72	1.72	1.72
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	3.2	2.8	2.6
S & M Factor of Safety	4.1	3.5	3.0
UNSW Factor of Safety (Power Law)	4.3	3.6	3.2
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

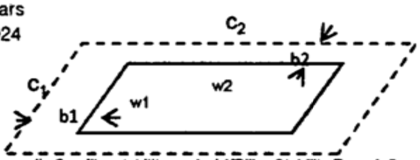
		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area B1-2**	**Area B1-2**	**Area B1-2**
Depth of Workings H (m)	33	33	33
Pillar Width w1 (m)	4.2	4.2	4.2
Pillar Length w2 (m)	18.8	18.8	18.8
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.11**	**0.85**	**0.69**
Tributary Area c1 (m)	9.10	9.10	9.10
Tributary Area c2 (m)	26.10	26.10	26.10
Vertical Stress Sv (MPa)	0.81	0.81	0.81
Bieniawski Strength (MPa)	4.38	3.99	3.75
Salamon & Munro Strength (MPa)	5.68	4.77	4.16
UNSW Strength (MPa) **w/h<5**	5.93	4.98	4.34
UNSW Strength (MPa) **w/h>5**	11.16	10.93	10.76
Pillar Load* - Obert & Duval (MPa)	2.43	2.43	2.43
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.8	1.6	1.5
S & M Factor of Safety	2.3	2.0	1.7
UNSW Factor of Safety (Power Law)	2.4	2.0	1.8
RESULT	Stable	Stable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

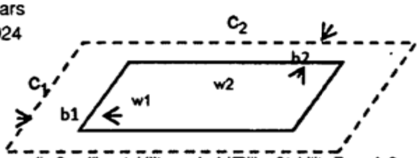
		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area B2-1**	**Area B2-1**	**Area B2-1**
Depth of Workings H (m)	41.5	41.5	41.5
Pillar Width w1 (m)	6.6	6.6	6.6
Pillar Length w2 (m)	19.7	19.7	19.7
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.74**	**1.33**	**1.08**
Tributary Area c1 (m)	11.50	11.50	11.50
Tributary Area c2 (m)	27.00	27.00	27.00
Vertical Stress Sv (MPa)	1.02	1.02	1.02
Bieniawski Strength (MPa)	5.33	4.72	4.34
Salamon & Munro Strength (MPa)	7.00	5.88	5.12
UNSW Strength (MPa) **w/h<5**	7.30	6.13	5.34
UNSW Strength (MPa) **w/h>5**	10.67	10.37	10.18
Pillar Load* - Obert & Duval (MPa)	2.43	2.43	2.43
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.2	1.9	1.8
S & M Factor of Safety	2.9	2.4	2.1
UNSW Factor of Safety (Power Law)	3.0	2.5	2.2
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

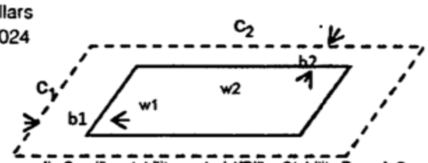
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area B2-2**	**Area B2-2**	**Area B2-2**
Depth of Workings H (m)	42.5	42.5	42.5
Pillar Width w1 (m)	5.2	5.2	5.2
Pillar Length w2 (m)	22.5	22.5	22.5
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.37**	**1.05**	**0.85**
Tributary Area c1 (m)	10.10	10.10	10.10
Tributary Area c2 (m)	29.80	29.80	29.80
Vertical Stress Sv (MPa)	1.04	1.04	1.04
Bieniawski Strength (MPa)	4.77	4.30	4.00
Salamon & Munro Strength (MPa)	6.27	5.27	4.59
UNSW Strength (MPa) **w/h<5**	6.55	5.50	4.79
UNSW Strength (MPa) **w/h>5**	10.91	10.65	10.48
Pillar Load* - Obert & Duval (MPa)	2.68	2.68	2.68
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.8	1.6	1.5
S & M Factor of Safety	2.3	2.0	1.7
UNSW Factor of Safety (Power Law)	2.4	2.1	1.8
RESULT	Stable	Stable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

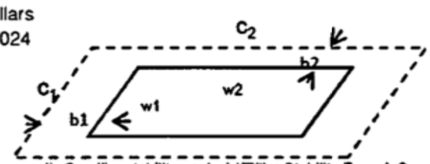
		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area B3**	**Area B3**	**Area B3**
Depth of Workings H (m)	46	46	46
Pillar Width w1 (m)	5	5	5
Pillar Length w2 (m)	17.9	17.9	17.9
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.32**	**1.01**	**0.82**
Tributary Area c1 (m)	9.90	9.90	9.90
Tributary Area c2 (m)	25.20	25.20	25.20
Vertical Stress Sv (MPa)	1.13	1.13	1.13
Bieniawski Strength (MPa)	4.69	4.24	3.95
Salamon & Munro Strength (MPa)	6.16	5.17	4.51
UNSW Strength (MPa) **w/h<5**	6.43	5.40	4.70
UNSW Strength (MPa) **w/h>5**	10.95	10.70	10.53
Pillar Load* - Obert & Duval (MPa)	3.14	3.14	3.14
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.5	1.3	1.3
S & M Factor of Safety	2.0	1.6	1.4
UNSW Factor of Safety (Power Law)	2.0	1.7	1.5
RESULT	Stable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

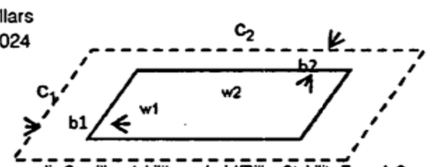
		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area B4**	**Area B4**	**Area B4**
Depth of Workings H (m)	46	46	46
Pillar Width w1 (m)	11	11	11
Pillar Length w2 (m)	25.5	25.5	25.5
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.3	4.3	4.3
Pillar width/height w/h	**2.89**	**2.22**	**1.80**
Tributary Area c1 (m)	15.30	15.30	15.30
Tributary Area c2 (m)	32.80	32.80	32.80
Vertical Stress Sv (MPa)	1.13	1.13	1.13
Bieniawski Strength (MPa)	7.06	6.05	5.42
Salamon & Munro Strength (MPa)	8.85	7.43	6.48
UNSW Strength (MPa) **w/h<5**	9.24	7.76	6.76
UNSW Strength (MPa) **w/h>5**	10.52	9.97	9.68
Pillar Load* - Obert & Duval (MPa)	2.02	2.02	2.02
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	3.5	3.0	2.7
S & M Factor of Safety	4.4	3.7	3.2
UNSW Factor of Safety (Power Law)	4.6	3.8	3.4
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

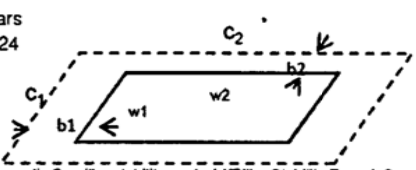
		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area C1**	**Area C1**	**Area C1**
Depth of Workings H (m)	53	53	53
Pillar Width w1 (m)	11.9	11.9	11.9
Pillar Length w2 (m)	34.4	34.4	34.4
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.3	4.3	4.3
Pillar width/height w/h	**3.13**	**2.40**	**1.95**
Tributary Area c1 (m)	16.20	16.20	16.20
Tributary Area c2 (m)	41.70	41.70	41.70
Vertical Stress Sv (MPa)	1.30	1.30	1.30
Bieniawski Strength (MPa)	7.42	6.33	5.65
Salamon & Munro Strength (MPa)	9.18	7.71	6.72
UNSW Strength (MPa) **w/h<5**	9.58	8.05	7.01
UNSW Strength (MPa) **w/h>5**	10.58	9.95	9.62
Pillar Load* - Obert & Duval (MPa)	2.14	2.14	2.14
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	3.5	3.0	2.6
S & M Factor of Safety	4.3	3.6	3.1
UNSW Factor of Safety (Power Law)	4.5	3.8	3.3
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

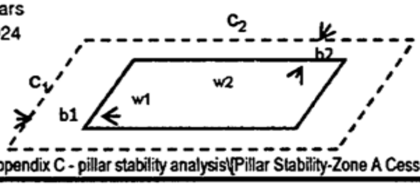
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area C2-1**	**Area C2-1**	**Area C2-1**
Depth of Workings H (m)	52.5	52.5	52.5
Pillar Width w1 (m)	9.7	9.7	9.7
Pillar Length w2 (m)	16.7	16.7	16.7
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**2.55**	**1.96**	**1.59**
Tributary Area c1 (m)	14.60	14.60	14.60
Tributary Area c2 (m)	24.00	24.00	24.00
Vertical Stress Sv (MPa)	1.29	1.29	1.29
Bieniawski Strength (MPa)	6.55	5.66	5.11
Salamon & Munro Strength (MPa)	8.35	7.02	6.11
UNSW Strength (MPa) **w/h<5**	8.72	7.32	6.38
UNSW Strength (MPa) **w/h>5**	10.49	10.03	9.78
Pillar Load* - Obert & Duval (MPa)	2.78	2.78	2.78
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.4	2.0	1.8
S & M Factor of Safety	3.0	2.5	2.2
UNSW Factor of Safety (Power Law)	3.1	2.6	2.3
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

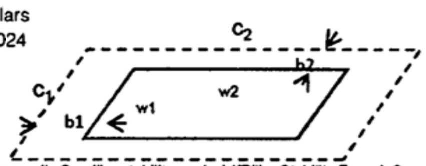
		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area C2-2**	**Area C2-2**	**Area C2-2**
Depth of Workings H (m)	49.8	49.8	49.8
Pillar Width w1 (m)	6	6	6
Pillar Length w2 (m)	15.6	15.6	15.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.9	4.9	4.9
Pillar width/height w/h	**1.58**	**1.21**	**0.98**
Tributary Area c1 (m)	10.90	10.90	10.90
Tributary Area c2 (m)	22.90	22.90	22.90
Vertical Stress Sv (MPa)	1.22	1.22	1.22
Bieniawski Strength (MPa)	5.09	4.54	4.20
Salamon & Munro Strength (MPa)	6.70	5.63	4.90
UNSW Strength (MPa) **w/h<5**	6.99	5.87	5.12
UNSW Strength (MPa) **w/h>5**	10.75	10.48	10.30
Pillar Load* - Obert & Duval (MPa)	3.25	3.25	3.25
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.6	1.4	1.3
S & M Factor of Safety	2.1	1.7	1.5
UNSW Factor of Safety (Power Law)	2.1	1.8	1.6
RESULT	Stable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

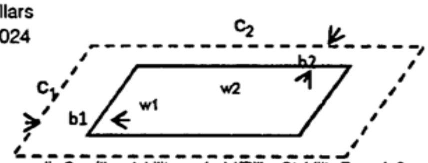
		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area D1**	**Area D1**	**Area D1**
Depth of Workings H (m)	18	18	18
Pillar Width w1 (m)	13.4	13.4	13.4
Pillar Length w2 (m)	15.4	15.4	15.4
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	7.3	7.3	7.3
Bord Width b2 (m)	4.3	4.3	4.3
Pillar width/height w/h	**3.53**	**2.71**	**2.20**
Tributary Area c1 (m)	17.70	17.70	17.70
Tributary Area c2 (m)	22.70	22.70	22.70
Vertical Stress Sv (MPa)	0.44	0.44	0.44
Bieniawski Strength (MPa)	8.01	6.78	6.02
Salamon & Munro Strength (MPa)	9.69	8.14	7.09
UNSW Strength (MPa) **w/h<5**	10.12	8.50	7.40
UNSW Strength (MPa) **w/h>5**	10.73	9.96	9.57
Pillar Load* - Obert & Duval (MPa)	0.86	0.86	0.86
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	9.3	7.9	7.0
S & M Factor of Safety	11.3	9.5	8.3
UNSW Factor of Safety (Power Law)	11.8	9.9	8.6
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



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Appendix D

Pillar stability sensitivity check output

Parsons Brinckerhoff

ABN 84797323433

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

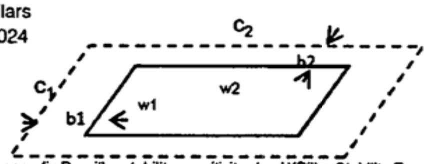
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A1**	**Area A1**	**Area A1**
Depth of Workings H (m)	19	19	19
Pillar Width w1 (m)	7.5	7.5	7.5
Pillar Length w2 (m)	16.6	16.6	16.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.97**	**1.52**	**1.23**
Tributary Area c1 (m)	13.40	13.40	13.40
Tributary Area c2 (m)	24.90	24.90	24.90
Vertical Stress Sv (MPa)	0.47	0.47	0.47
Bieniawski Strength (MPa)	5.68	4.99	4.56
Salamon & Munro Strength (MPa)	7.42	6.23	5.43
UNSW Strength (MPa) **w/h<5**	7.75	6.51	5.67
UNSW Strength (MPa) **w/h>5**	10.57	10.24	10.03
Pillar Load* - Obert & Duval (MPa)	1.25	1.25	1.25
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	4.6	4.0	3.7
S & M Factor of Safety	5.9	5.0	4.4
UNSW Factor of Safety (Power Law)	6.2	5.2	4.5
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

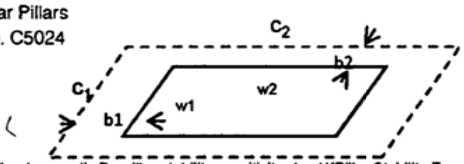
		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A2**	**Area A2**	**Area A2**
Depth of Workings H (m)	26	26	26
Pillar Width w1 (m)	13.3	13.3	13.3
Pillar Length w2 (m)	23.1	23.1	23.1
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.3	5.3	5.3
Pillar width/height w/h	**3.50**	**2.69**	**2.18**
Tributary Area c1 (m)	18.60	18.60	18.60
Tributary Area c2 (m)	31.40	31.40	31.40
Vertical Stress Sv (MPa)	0.64	0.64	0.64
Bieniawski Strength (MPa)	7.97	6.75	5.99
Salamon & Munro Strength (MPa)	9.66	8.11	7.07
UNSW Strength (MPa) **w/h<5**	10.08	8.47	7.38
UNSW Strength (MPa) **w/h>5**	10.72	9.95	9.57
Pillar Load* - Obert & Duval (MPa)	1.21	1.21	1.21
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	6.6	5.6	4.9
S & M Factor of Safety	8.0	6.7	5.8
UNSW Factor of Safety (Power Law)	8.3	7.0	6.1
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



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Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

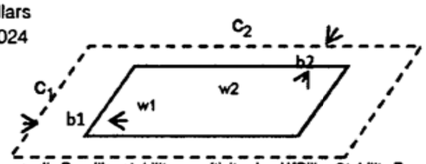
		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A3-1**	**Area A3-1**	**Area A3-1**
Depth of Workings H (m)	30	30	30
Pillar Width w1 (m)	8.3	8.3	8.3
Pillar Length w2 (m)	17.9	17.9	17.9
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**2.18**	**1.68**	**1.36**
Tributary Area c1 (m)	14.20	14.20	14.20
Tributary Area c2 (m)	26.20	26.20	26.20
Vertical Stress Sv (MPa)	0.74	0.74	0.74
Bieniawski Strength (MPa)	6.00	5.24	4.76
Salamon & Munro Strength (MPa)	7.78	6.53	5.69
UNSW Strength (MPa) **w/h<5**	8.12	6.82	5.94
UNSW Strength (MPa) **w/h>5**	10.52	10.15	9.93
Pillar Load* - Obert & Duval (MPa)	1.84	1.84	1.84
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	3.3	2.8	2.6
S & M Factor of Safety	4.2	3.5	3.1
UNSW Factor of Safety (Power Law)	4.4	3.7	3.2
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

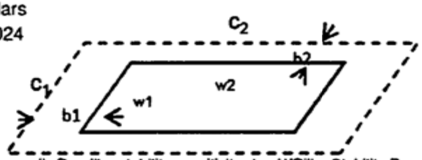
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A3-2**	**Area A3-2**	**Area A3-2**
Depth of Workings H (m)	35	35	35
Pillar Width w1 (m)	5.9	5.9	5.9
Pillar Length w2 (m)	17.6	17.6	17.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.55**	**1.19**	**0.97**
Tributary Area c1 (m)	11.80	11.80	11.80
Tributary Area c2 (m)	25.90	25.90	25.90
Vertical Stress Sv (MPa)	0.86	0.86	0.86
Bieniawski Strength (MPa)	5.05	4.51	4.17
Salamon & Munro Strength (MPa)	6.65	5.58	4.86
UNSW Strength (MPa) **w/h<5**	6.94	5.83	5.08
UNSW Strength (MPa) **w/h>5**	10.77	10.50	10.32
Pillar Load* - Obert & Duval (MPa)	2.52	2.52	2.52
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.0	1.8	1.7
S & M Factor of Safety	2.6	2.2	1.9
UNSW Factor of Safety (Power Law)	2.7	2.3	2.0
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

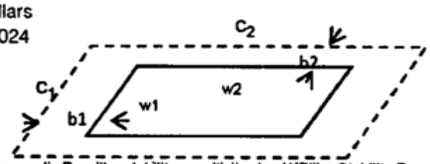
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A4**	**Area A4**	**Area A4**
Depth of Workings H (m)	34	34	34
Pillar Width w1 (m)	9.1	9.1	9.1
Pillar Length w2 (m)	18.8	18.8	18.8
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**2.39**	**1.84**	**1.49**
Tributary Area c1 (m)	15.00	15.00	15.00
Tributary Area c2 (m)	27.10	27.10	27.10
Vertical Stress Sv (MPa)	0.83	0.83	0.83
Bieniawski Strength (MPa)	6.31	5.48	4.96
Salamon & Munro Strength (MPa)	8.11	6.81	5.94
UNSW Strength (MPa) **w/h<5**	8.47	7.11	6.20
UNSW Strength (MPa) **w/h>5**	10.49	10.07	9.83
Pillar Load* - Obert & Duval (MPa)	1.98	1.98	1.98
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	3.2	2.8	2.5
S & M Factor of Safety	4.1	3.4	3.0
UNSW Factor of Safety (Power Law)	4.3	3.6	3.1
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

Job Number	2122827B	Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

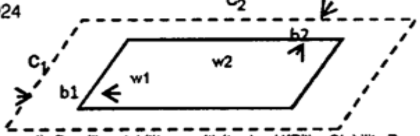
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A5**	**Area A5**	**Area A5**
Depth of Workings H (m)	45.5	45.5	45.5
Pillar Width w1 (m)	6.8	6.8	6.8
Pillar Length w2 (m)	17.3	17.3	17.3
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.79**	**1.37**	**1.11**
Tributary Area c1 (m)	12.70	12.70	12.70
Tributary Area c2 (m)	25.60	25.60	25.60
Vertical Stress Sv (MPa)	1.11	1.11	1.11
Bieniawski Strength (MPa)	5.40	4.78	4.39
Salamon & Munro Strength (MPa)	7.09	5.96	5.19
UNSW Strength (MPa) **w/h<5**	7.41	6.22	5.42
UNSW Strength (MPa) **w/h>5**	10.64	10.34	10.15
Pillar Load* - Obert & Duval (MPa)	3.08	3.08	3.08
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.8	1.6	1.4
S & M Factor of Safety	2.3	1.9	1.7
UNSW Factor of Safety (Power Law)	2.4	2.0	1.8
RESULT	Stable	Stable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

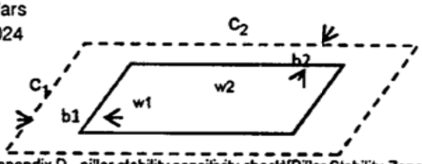
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A6**	**Area A6**	**Area A6**
Depth of Workings H (m)	44	44	44
Pillar Width w1 (m)	6.6	6.6	6.6
Pillar Length w2 (m)	16.1	16.1	16.1
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.74**	**1.33**	**1.08**
Tributary Area c1 (m)	12.50	12.50	12.50
Tributary Area c2 (m)	24.40	24.40	24.40
Vertical Stress Sv (MPa)	1.08	1.08	1.08
Bieniawski Strength (MPa)	5.33	4.72	4.34
Salamon & Munro Strength (MPa)	7.00	5.88	5.12
UNSW Strength (MPa) **w/h<5**	7.30	6.13	5.34
UNSW Strength (MPa) **w/h>5**	10.67	10.37	10.18
Pillar Load* - Obert & Duval (MPa)	3.09	3.09	3.09
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.7	1.5	1.4
S & M Factor of Safety	2.3	1.9	1.7
UNSW Factor of Safety (Power Law)	2.4	2.0	1.7
RESULT	Stable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

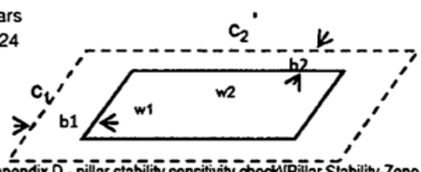
		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A7-1**	**Area A7-1**	**Area A7-1**
Depth of Workings H (m)	40	40	40
Pillar Width w1 (m)	9.7	9.7	9.7
Pillar Length w2 (m)	17.6	17.6	17.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**2.55**	**1.96**	**1.59**
Tributary Area c1 (m)	15.60	15.60	15.60
Tributary Area c2 (m)	25.90	25.90	25.90
Vertical Stress Sv (MPa)	0.98	0.98	0.98
Bieniawski Strength (MPa)	6.55	5.66	5.11
Salamon & Munro Strength (MPa)	8.35	7.02	6.11
UNSW Strength (MPa) **w/h<5**	8.72	7.32	6.38
UNSW Strength (MPa) **w/h>5**	10.49	10.03	9.78
Pillar Load* - Obert & Duval (MPa)	2.32	2.32	2.32
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.8	2.4	2.2
S & M Factor of Safety	3.6	3.0	2.6
UNSW Factor of Safety (Power Law)	3.8	3.2	2.8
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

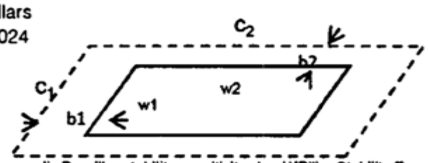
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A7-2**	**Area A7-2**	**Area A7-2**
Depth of Workings H (m)	44.3	44.3	44.3
Pillar Width w1 (m)	4.8	4.8	4.8
Pillar Length w2 (m)	16.5	16.5	16.5
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.26**	**0.97**	**0.79**
Tributary Area c1 (m)	10.70	10.70	10.70
Tributary Area c2 (m)	24.80	24.80	24.80
Vertical Stress Sv (MPa)	1.09	1.09	1.09
Bieniawski Strength (MPa)	4.61	4.17	3.90
Salamon & Munro Strength (MPa)	6.04	5.08	4.42
UNSW Strength (MPa) **w/h<5**	6.31	5.30	4.62
UNSW Strength (MPa) **w/h>5**	11.00	10.75	10.58
Pillar Load* - Obert & Duval (MPa)	3.64	3.64	3.64
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.3	1.1	1.1
S & M Factor of Safety	1.7	1.4	1.2
UNSW Factor of Safety (Power Law)	1.7	1.5	1.3
RESULT	Unstable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

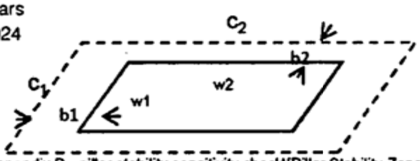
Job Number	2122827B	Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A8-1**	**Area A8-1**	**Area A8-1**
Depth of Workings H (m)	37.7	37.7	37.7
Pillar Width w1 (m)	8.7	8.7	8.7
Pillar Length w2 (m)	16.3	16.3	16.3
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**2.29**	**1.76**	**1.43**
Tributary Area c1 (m)	14.60	14.60	14.60
Tributary Area c2 (m)	24.60	24.60	24.60
Vertical Stress Sv (MPa)	0.92	0.92	0.92
Bieniawski Strength (MPa)	6.15	5.36	4.86
Salamon & Munro Strength (MPa)	7.95	6.67	5.81
UNSW Strength (MPa) **w/h<5**	8.29	6.97	6.07
UNSW Strength (MPa) **w/h>5**	10.50	10.11	9.88
Pillar Load* - Obert & Duval (MPa)	2.34	2.34	2.34
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.6	2.3	2.1
S & M Factor of Safety	3.4	2.9	2.5
UNSW Factor of Safety (Power Law)	3.5	3.0	2.6
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

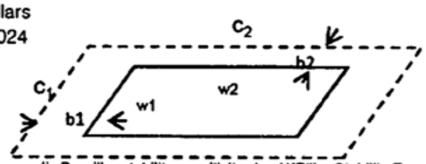
		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A8-2**	**Area A8-2**	**Area A8-2**
Depth of Workings H (m)	42	42	42
Pillar Width w1 (m)	5.5	5.5	5.5
Pillar Length w2 (m)	16.6	16.6	16.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.45**	**1.11**	**0.90**
Tributary Area c1 (m)	11.40	11.40	11.40
Tributary Area c2 (m)	24.90	24.90	24.90
Vertical Stress Sv (MPa)	1.03	1.03	1.03
Bieniawski Strength (MPa)	4.89	4.39	4.07
Salamon & Munro Strength (MPa)	6.44	5.40	4.71
UNSW Strength (MPa) **w/h<5**	6.72	5.64	4.91
UNSW Strength (MPa) **w/h>5**	10.84	10.58	10.41
Pillar Load* - Obert & Duval (MPa)	3.20	3.20	3.20
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.5	1.4	1.3
S & M Factor of Safety	2.0	1.7	1.5
UNSW Factor of Safety (Power Law)	2.1	1.8	1.5
RESULT	Stable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-1**	**Area A9-1**	**Area A9-1**
Depth of Workings H (m)	49	49	49
Pillar Width w1 (m)	9.5	9.5	9.5
Pillar Length w2 (m)	13.8	13.8	13.8
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**2.50**	**1.92**	**1.56**
Tributary Area c1 (m)	15.40	15.40	15.40
Tributary Area c2 (m)	22.10	22.10	22.10
Vertical Stress Sv (MPa)	1.20	1.20	1.20
Bieniawski Strength (MPa)	6.47	5.60	5.06
Salamon & Munro Strength (MPa)	8.27	6.95	6.05
UNSW Strength (MPa) **w/h<5**	8.64	7.25	6.32
UNSW Strength (MPa) **w/h>5**	10.49	10.05	9.79
Pillar Load* - Obert & Duval (MPa)	3.12	3.12	3.12
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.1	1.8	1.6
S & M Factor of Safety	2.7	2.2	1.9
UNSW Factor of Safety (Power Law)	2.8	2.3	2.0
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

Job Number	2122827B	Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A9-2**	**Area A9-2**	**Area A9-2**
Depth of Workings H (m)	49	49	49
Pillar Width w1 (m)	6.5	6.5	6.5
Pillar Length w2 (m)	12.6	12.6	12.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.71**	**1.31**	**1.07**
Tributary Area c1 (m)	12.40	12.40	12.40
Tributary Area c2 (m)	20.90	20.90	20.90
Vertical Stress Sv (MPa)	1.20	1.20	1.20
Bieniawski Strength (MPa)	5.29	4.69	4.32
Salamon & Munro Strength (MPa)	6.95	5.84	5.08
UNSW Strength (MPa) **w/h<5**	7.25	6.09	5.31
UNSW Strength (MPa) **w/h>5**	10.68	10.39	10.20
Pillar Load* - Obert & Duval (MPa)	3.80	3.80	3.80
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.4	1.2	1.1
S & M Factor of Safety	1.8	1.5	1.3
UNSW Factor of Safety (Power Law)	1.9	1.6	1.4
RESULT	Unstable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

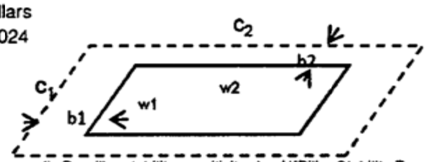
		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area A10-1**	**Area A10-1**	**Area A10-1**
Depth of Workings H (m)	47.5	47.5	47.5
Pillar Width w1 (m)	5.6	5.6	5.6
Pillar Length w2 (m)	16.6	16.6	16.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.47**	**1.13**	**0.92**
Tributary Area c1 (m)	11.50	11.50	11.50
Tributary Area c2 (m)	24.90	24.90	24.90
Vertical Stress Sv (MPa)	1.16	1.16	1.16
Bieniawski Strength (MPa)	4.93	4.42	4.10
Salamon & Munro Strength (MPa)	6.49	5.45	4.75
UNSW Strength (MPa) **w/h<5**	6.77	5.69	4.96
UNSW Strength (MPa) **w/h>5**	10.82	10.56	10.38
Pillar Load* - Obert & Duval (MPa)	3.58	3.58	3.58
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.4	1.2	1.1
S & M Factor of Safety	1.8	1.5	1.3
UNSW Factor of Safety (Power Law)	1.9	1.6	1.4
RESULT	Unstable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

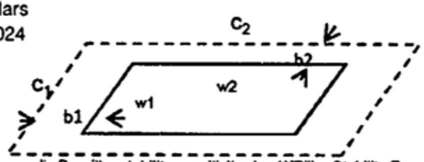
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area A10-2**	**Area A10-2**	**Area A10-2**
Depth of Workings H (m)	48.5	48.5	48.5
Pillar Width w1 (m)	4.5	4.5	4.5
Pillar Length w2 (m)	15.3	15.3	15.3
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.18**	**0.91**	**0.74**
Tributary Area c1 (m)	10.40	10.40	10.40
Tributary Area c2 (m)	23.60	23.60	23.60
Vertical Stress Sv (MPa)	1.19	1.19	1.19
Bieniawski Strength (MPa)	4.50	4.08	3.83
Salamon & Munro Strength (MPa)	5.87	4.93	4.29
UNSW Strength (MPa) **w/h<5**	6.12	5.14	4.48
UNSW Strength (MPa) **w/h>5**	11.08	10.84	10.67
Pillar Load* - Obert & Duval (MPa)	4.24	4.24	4.24
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.1	1.0	0.9
S & M Factor of Safety	1.4	1.2	1.0
UNSW Factor of Safety (Power Law)	1.4	1.2	1.1
RESULT	Unstable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area B1-1**	**Area B1-1**	**Area B1-1**
Depth of Workings H (m)	29	29	29
Pillar Width w1 (m)	5.9	5.9	5.9
Pillar Length w2 (m)	16.4	16.4	16.4
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.55**	**1.19**	**0.97**
Tributary Area c1 (m)	11.80	11.80	11.80
Tributary Area c2 (m)	24.70	24.70	24.70
Vertical Stress Sv (MPa)	0.71	0.71	0.71
Bieniawski Strength (MPa)	5.05	4.51	4.17
Salamon & Munro Strength (MPa)	6.65	5.58	4.86
UNSW Strength (MPa) **w/h<5**	6.94	5.83	5.08
UNSW Strength (MPa) **w/h>5**	10.77	10.50	10.32
Pillar Load* - Obert & Duval (MPa)	2.14	2.14	2.14
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.4	2.1	1.9
S & M Factor of Safety	3.1	2.6	2.3
UNSW Factor of Safety (Power Law)	3.2	2.7	2.4
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

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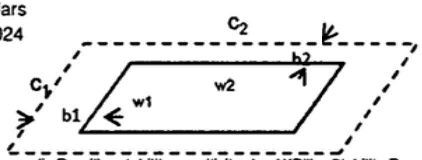

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

Job Number	2122827B		
Sheet	2 of 2		
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area B1-2**	**Area B1-2**	**Area B1-2**
Depth of Workings H (m)	33	33	33
Pillar Width w1 (m)	3.2	3.2	3.2
Pillar Length w2 (m)	17.8	17.8	17.8
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**0.84**	**0.65**	**0.52**
Tributary Area c1 (m)	9.10	9.10	9.10
Tributary Area c2 (m)	26.10	26.10	26.10
Vertical Stress Sv (MPa)	0.81	0.81	0.81
Bieniawski Strength (MPa)	3.98	3.69	3.51
Salamon & Munro Strength (MPa)	5.02	4.21	3.67
UNSW Strength (MPa) **w/h<5**	5.24	4.40	3.83
UNSW Strength (MPa) **w/h>5**	11.54	11.31	11.15
Pillar Load* - Obert & Duval (MPa)	3.37	3.37	3.37
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.2	1.1	1.0
S & M Factor of Safety	1.5	1.2	1.1
UNSW Factor of Safety (Power Law)	1.6	1.3	1.1
RESULT	Unstable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

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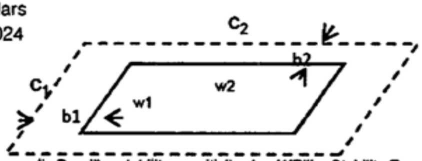

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area B2-1**	**Area B2-1**	**Area B2-1**
Depth of Workings H (m)	41.5	41.5	41.5
Pillar Width w1 (m)	5.6	5.6	5.6
Pillar Length w2 (m)	18.7	18.7	18.7
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.47**	**1.13**	**0.92**
Tributary Area c1 (m)	11.50	11.50	11.50
Tributary Area c2 (m)	27.00	27.00	27.00
Vertical Stress Sv (MPa)	1.02	1.02	1.02
Bieniawski Strength (MPa)	4.93	4.42	4.10
Salamon & Munro Strength (MPa)	6.49	5.45	4.75
UNSW Strength (MPa) **w/h<5**	6.77	5.69	4.96
UNSW Strength (MPa) **w/h>5**	10.82	10.56	10.38
Pillar Load* - Obert & Duval (MPa)	3.01	3.01	3.01
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.6	1.5	1.4
S & M Factor of Safety	2.2	1.8	1.6
UNSW Factor of Safety (Power Law)	2.2	1.9	1.6
RESULT	Stable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

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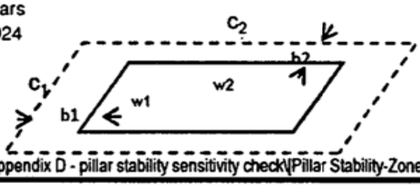

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area B2-2**	**Area B2-2**	**Area B2-2**
Depth of Workings H (m)	42.5	42.5	42.5
Pillar Width w1 (m)	4.2	4.2	4.2
Pillar Length w2 (m)	21.5	21.5	21.5
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.11**	**0.85**	**0.69**
Tributary Area c1 (m)	10.10	10.10	10.10
Tributary Area c2 (m)	29.80	29.80	29.80
Vertical Stress Sv (MPa)	1.04	1.04	1.04
Bieniawski Strength (MPa)	4.38	3.99	3.75
Salamon & Munro Strength (MPa)	5.68	4.77	4.16
UNSW Strength (MPa) **w/h<5**	5.93	4.98	4.34
UNSW Strength (MPa) **w/h>5**	11.16	10.93	10.76
Pillar Load* - Obert & Duval (MPa)	3.47	3.47	3.47
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.3	1.2	1.1
S & M Factor of Safety	1.6	1.4	1.2
UNSW Factor of Safety (Power Law)	1.7	1.4	1.3
RESULT	Unstable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

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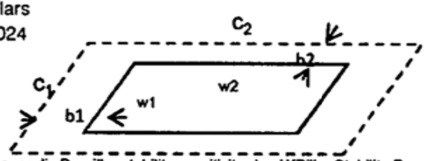

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

Job Number	2122827B		
Sheet	1 of 1		
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area B3**	**Area B3**	**Area B3**
Depth of Workings H (m)	46	46	46
Pillar Width w1 (m)	4	4	4
Pillar Length w2 (m)	16.9	16.9	16.9
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.05**	**0.81**	**0.66**
Tributary Area c1 (m)	9.90	9.90	9.90
Tributary Area c2 (m)	25.20	25.20	25.20
Vertical Stress Sv (MPa)	1.13	1.13	1.13
Bieniawski Strength (MPa)	4.30	3.93	3.70
Salamon & Munro Strength (MPa)	5.56	4.67	4.07
UNSW Strength (MPa) **w/h<5**	5.80	4.87	4.24
UNSW Strength (MPa) **w/h>5**	11.23	11.00	10.83
Pillar Load* - Obert & Duval (MPa)	4.16	4.16	4.16
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.0	0.9	0.9
S & M Factor of Safety	1.3	1.1	1.0
UNSW Factor of Safety (Power Law)	1.4	1.2	1.0
RESULT	Unstable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

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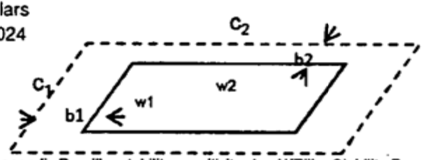

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area B4**	**Area B4**	**Area B4**
Depth of Workings H (m)	46	46	46
Pillar Width w1 (m)	10	10	10
Pillar Length w2 (m)	24.5	24.5	24.5
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.3	5.3	5.3
Pillar width/height w/h	**2.63**	**2.02**	**1.64**
Tributary Area c1 (m)	15.30	15.30	15.30
Tributary Area c2 (m)	32.80	32.80	32.80
Vertical Stress Sv (MPa)	1.13	1.13	1.13
Bieniawski Strength (MPa)	6.67	5.75	5.18
Salamon & Munro Strength (MPa)	8.47	7.12	6.20
UNSW Strength (MPa) **w/h<5**	8.84	7.43	6.47
UNSW Strength (MPa) **w/h>5**	10.49	10.01	9.75
Pillar Load* - Obert & Duval (MPa)	2.31	2.31	2.31
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.9	2.5	2.2
S & M Factor of Safety	3.7	3.1	2.7
UNSW Factor of Safety (Power Law)	3.8	3.2	2.8
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

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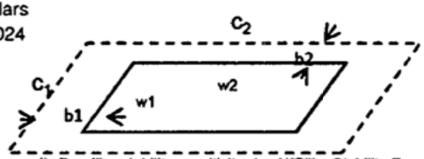

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area C1**	**Area C1**	**Area C1**
Depth of Workings H (m)	53	53	53
Pillar Width w1 (m)	10.9	10.9	10.9
Pillar Length w2 (m)	33.4	33.4	33.4
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.3	5.3	5.3
Pillar width/height w/h	**2.87**	**2.20**	**1.79**
Tributary Area c1 (m)	16.20	16.20	16.20
Tributary Area c2 (m)	41.70	41.70	41.70
Vertical Stress Sv (MPa)	1.30	1.30	1.30
Bieniawski Strength (MPa)	7.02	6.02	5.40
Salamon & Munro Strength (MPa)	8.81	7.40	6.45
UNSW Strength (MPa) **w/h<5**	9.20	7.73	6.73
UNSW Strength (MPa) **w/h>5**	10.52	9.97	9.68
Pillar Load* - Obert & Duval (MPa)	2.41	2.41	2.41
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	2.9	2.5	2.2
S & M Factor of Safety	3.7	3.1	2.7
UNSW Factor of Safety (Power Law)	3.8	3.2	2.8
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

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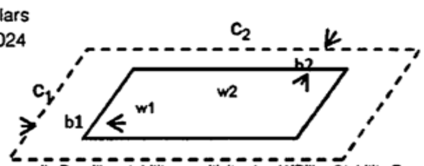

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area C2-1**	**Area C2-1**	**Area C2-1**
Depth of Workings H (m)	52.5	52.5	52.5
Pillar Width w1 (m)	8.7	8.7	8.7
Pillar Length w2 (m)	15.7	15.7	15.7
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**2.29**	**1.76**	**1.43**
Tributary Area c1 (m)	14.60	14.60	14.60
Tributary Area c2 (m)	24.00	24.00	24.00
Vertical Stress Sv (MPa)	1.29	1.29	1.29
Bieniawski Strength (MPa)	6.15	5.36	4.86
Salamon & Munro Strength (MPa)	7.95	6.67	5.81
UNSW Strength (MPa) **w/h<5**	8.29	6.97	6.07
UNSW Strength (MPa) **w/h>5**	10.50	10.11	9.88
Pillar Load* - Obert & Duval (MPa)	3.30	3.30	3.30
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.9	1.6	1.5
S & M Factor of Safety	2.4	2.0	1.8
UNSW Factor of Safety (Power Law)	2.5	2.1	1.8
RESULT	Stable	Stable	Unstable

*Full Tributary Area Load

NOTES:

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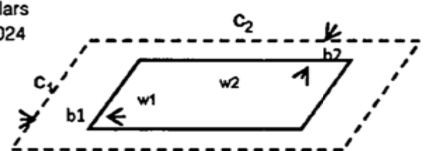

Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	2 of 2
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

PILLAR STABILITY			
Coal seam	Greta	Greta	Greta
Pillar ID	**Area C2-2**	**Area C2-2**	**Area C2-2**
Depth of Workings H (m)	49.8	49.8	49.8
Pillar Width w1 (m)	5	5	5
Pillar Length w2 (m)	14.6	14.6	14.6
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.9	5.9	5.9
Pillar width/height w/h	**1.32**	**1.01**	**0.82**
Tributary Area c1 (m)	10.90	10.90	10.90
Tributary Area c2 (m)	22.90	22.90	22.90
Vertical Stress Sv (MPa)	1.22	1.22	1.22
Bieniawski Strength (MPa)	4.69	4.24	3.95
Salamon & Munro Strength (MPa)	6.16	5.17	4.51
UNSW Strength (MPa) **w/h<5**	6.43	5.40	4.70
UNSW Strength (MPa) **w/h>5**	10.95	10.70	10.53
Pillar Load* - Obert & Duval (MPa)	4.17	4.17	4.17
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	1.1	1.0	0.9
S & M Factor of Safety	1.5	1.2	1.1
UNSW Factor of Safety (Power Law)	1.5	1.3	1.1
RESULT	Unstable	Unstable	Unstable

*Full Tributary Area Load

NOTES:

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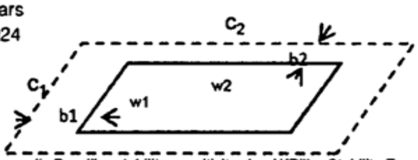


Parsons Brinckerhoff

ABN 80 078 004 798

Pillar Stability Calculation

		Job Number	2122827B
		Sheet	1 of 1
Client	Hunter Land/Regional Land Joint Venture	Office	Newcastle
Principal		Date	22 October 2009
Project	Cessnock Civic Centre - Zone A	By	RIK
Location	Vincent Street, Cessnock	Checked	JNA

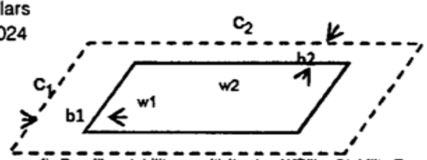
PILLAR STABILITY

Coal seam	Greta	Greta	Greta
Pillar ID	**Area D1**	**Area D1**	**Area D1**
Depth of Workings H (m)	18	18	18
Pillar Width w1 (m)	12.4	12.4	12.4
Pillar Length w2 (m)	14.4	14.4	14.4
Pillar Height h (m)	3.8	4.95	6.1
Bord Width b1 (m)	8.3	8.3	8.3
Bord Width b2 (m)	5.3	5.3	5.3
Pillar width/height w/h	**3.26**	**2.51**	**2.03**
Tributary Area c1 (m)	17.70	17.70	17.70
Tributary Area c2 (m)	22.70	22.70	22.70
Vertical Stress Sv (MPa)	0.44	0.44	0.44
Bieniawski Strength (MPa)	7.61	6.48	5.77
Salamon & Munro Strength (MPa)	9.35	7.86	6.84
UNSW Strength (MPa) **w/h<5**	9.76	8.20	7.14
UNSW Strength (MPa) **w/h>5**	10.62	9.95	9.60
Pillar Load* - Obert & Duval (MPa)	0.99	0.99	0.99
Choose Correct UNSW Strength for w/h			
Bieniawski Factor of Safety	7.7	6.5	5.8
S & M Factor of Safety	9.4	7.9	6.9
UNSW Factor of Safety (Power Law)	9.8	8.3	7.2
RESULT	Stable	Stable	Stable

*Full Tributary Area Load

NOTES:

1. Pillar Strength Formulas are UNSW Power Law Formulas for Rectangular and Irregular Pillars (J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B Lin) ACARP Research Report No. C5024 UNSW Dec 1998



J:\A237 - HUN\PROJ\2122827B__Geo_Cessnock_C\05_WrkPapers\WP\Draft\interpretative report\appendices\appendix D - pillar stability sensitivity check\[Pillar Stability-Zone A Ce

Appendix E

Limitations of geotechnical investigation

Scope of services

This geotechnical site assessment report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and PB (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on data

In preparing the report, PB has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, PB has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. PB will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to PB.

Geotechnical investigation

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared to meet the specific needs of individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor or even some other consulting civil engineer. This report was prepared expressly for the client and expressly for purposes indicated by the client or his representative. Use by any other persons for any purpose, or by the client for a different purpose, might result in problems. The client should not use this report for other than its intended purpose without seeking additional geotechnical advice.

This geotechnical report is based on project-specific factors

This geotechnical engineering report is based on a subsurface investigation which was designed for project-specification factors, including the nature of any development, its size and configuration, the location of any development on the site and its orientation, and the location of access roads and parking areas. Unless further geotechnical advice is obtained this geotechnical engineering report cannot be used:

- when the nature of any proposed development is changed
- when the size, configuration location or orientation of any proposed development is modified.

This geotechnical engineering report cannot be applied to an adjacent site.

The limitations of site investigation

In making an assessment of a site from a limited number of boreholes or test pits there is the possibility that variations may occur between test locations. Site exploration identifies specific subsurface conditions only at those points from which samples have been taken. The risk that variations will not be detected can be reduced by increasing the frequency of test locations; however this often does not result in any overall cost savings for the project. The investigation program undertaken is a professional estimate of the scope of investigation required to provide a general profile of the subsurface conditions. The data derived from the site investigation program and subsequent laboratory testing are extrapolated across the site to form an inferred geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

The borehole logs are the subjective interpretation of subsurface conditions at a particular location, made by trained personnel. The interpretation may be limited by the method of investigation, and can not always be definitive. For example, inspection of an excavation or test pit allows a greater area of the subsurface profile to be inspected than borehole investigation, however, such methods are limited by depth and site disturbance restrictions. In borehole investigation, the actual interface between materials may be more gradual or abrupt than a report indicates.

Subsurface conditions are time dependent

Subsurface conditions may be modified by changing natural forces or man-made influences. A geotechnical engineering report is based on conditions which existed at the time of subsurface exploration.

Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept appraised of any such events, and should be consulted to determine if additional tests are necessary.

Avoid misinterpretation

A geotechnical engineer should be retained to work with other appropriate design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

Bore/profile logs should not be separated from the engineering report

Final bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings. To minimise the likelihood of bore/profile log misinterpretation, contractors should be given access to the complete geotechnical engineering report prepared or authorised for their use. Providing the best available information to contractors helps prevent costly construction problems. For further information on this matter reference should be made to 'Guidelines for the Provision of Geotechnical Information in Construction Contracts' published by the Institution of Engineers Australia, National Headquarters, Canberra 1987.

Geotechnical involvement during construction

During construction, excavation is frequently undertaken which exposes the actual subsurface conditions. For this reason geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed and to conduct additional tests which may be required and to deal quickly with geotechnical problems if they arise.

Report for benefit of client

The report has been prepared for the benefit of the client and no other party. PB assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of PB or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other limitations

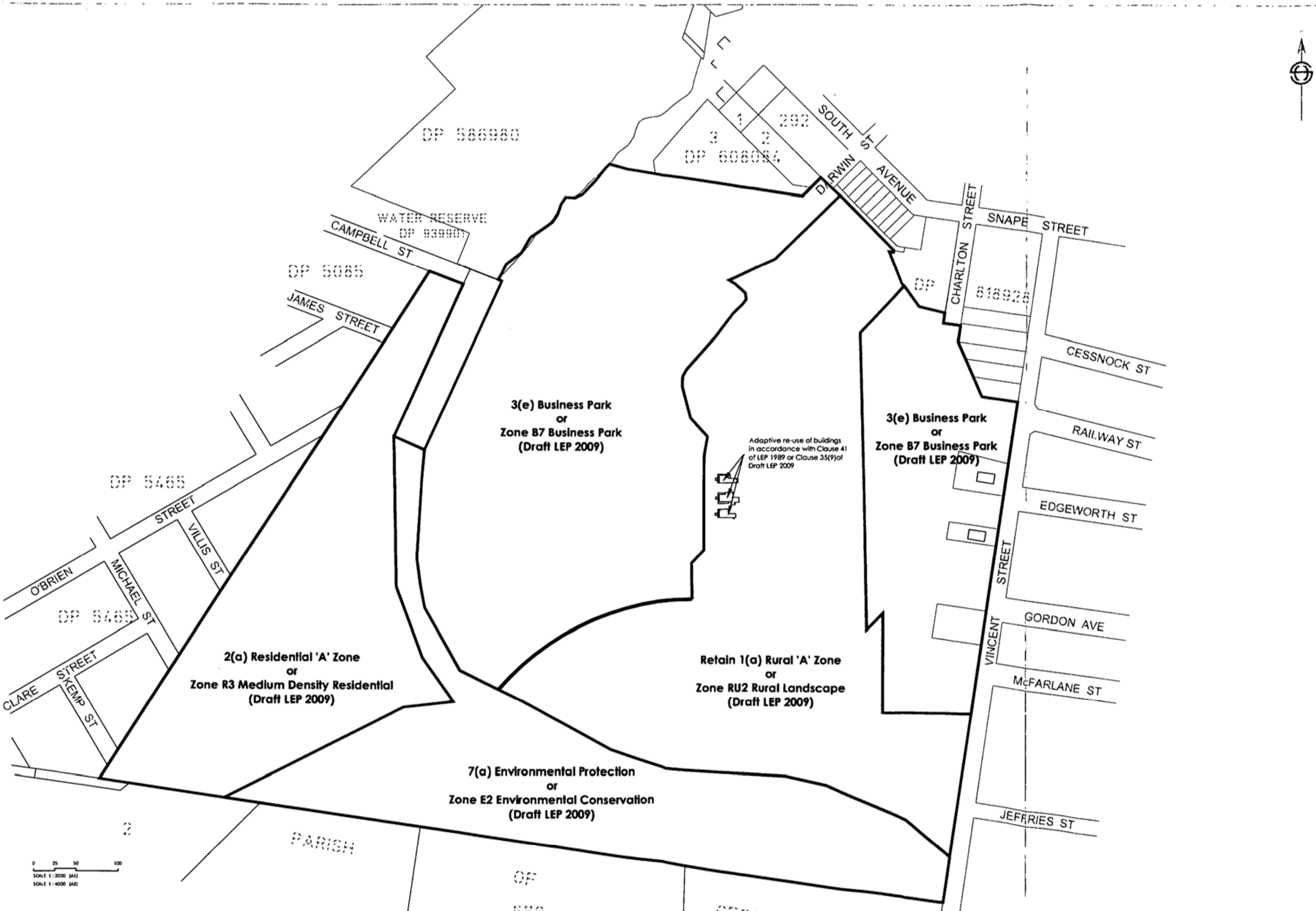
PB will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Amendment details

Revision	Details	Date	By
A	Original	18/07/08	M Jenkins

Appendix F

Proposed zoning plan



PROPOSED ZONING PLAN
CESSNOCK CIVIC BUSINESS PARK

LOCATION: VINCENT STREET
CESSNOCK

DATUM/PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 23RD MARCH 2010
PURPOSE: PROPOSED ZONING

AUTOCAD REF: 22257 - 2J
VERSION: PROPOSED ZONING

VINCENT STREET HOLDINGS PTY LTD
22257

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