M2012/9

QUESTION ON NOTICE

Inquiry into Coal Seam Gas

DUE AT Legislative Council: 30 January 2012

DEPARTMENT OF PRIMARY INDUSTRIES
Sydney Catchment Authority

Inquiry into Coal Seam Gas

Issue:
Michael Bullen, Chief Executive Sydney Catchment Authority, appeared before the Legislative Council's General Purpose Standing Committee No. 5 on 12 December 2011. A number of questions at the hearing were taken on notice. Answers to questions on notice and corrections of the transcript are due to the Committee's secretariat on 30 January 2012.

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Michael Bullen, Chief Executive

QUESTIONS ON NOTICE:

QUESTION
The Hon. JEREMY BUCKINGHAM: You said that you considered exploration low risk. What is your view of the other processes: pilot production, production, pipelines and ongoing maintenance? Has the Sydney Catchment Authority done a risk assessment of the various phases of coal seam gas development? What is that assessment?
Mr BULLEN: In some ways this is a hypothetical question because at the moment the only approval is for exploratory drilling. The most recent Department of Planning decision makes it very clear that this approval is for exploration drilling only and any subsequent activity would be subject to a completely separate planning proposal and consideration by Government. To come to the other part of the question that you asked, the SCA, as part of its due diligence about understanding this industry, has gone through and looked at the various phases of the operation of coal seam gas and considered other potential impacts on the environment as this activity may proceed and made a determination that the risks can be greater as it moves to dewatering and fracturing, for example, and also in relation to production. If production requires the clearing of vegetation, for example, within an area of operations then there is a potential for risk to water quality as a result of that.
The Hon. JEREMY BUCKINGHAM: Is that a formal process you have done? Did you commission work from staff on that? Did you produce a strategy document or a paper in that regard?
Mr BULLEN: No, we did not produce a paper but we looked at the range of activities and produced a table that identified what those risks may be. In doing a risk assessment process, there are a number of things that are considered. In a risk assessment process there are two outcomes. One is a risk where that activity is not modified or mitigated. Then there is a residual risk after mitigation and modification actions are undertaken.
The Hon. JEREMY BUCKINGHAM: Can you table that risk assessment?
Mr BULLEN: I will take that on notice and provide it to the Committee.

ANSWER
The general coal seam gas project stages are attached at **TABLE A**, Apex exploration drilling program at **TABLE B** and the risk assessment at **TABLES C** and **D.**

QUESTION
The Hon. RICK COLLESS: What can you tell us about the Wingecarribee area from your experience? What can you tell us in general terms about the depth of the aquifers in that area?
Mr BULLEN: I would have to take that question on notice and we will be able to come back to the Committee on it.

ANSWER
Based on two borehole data logs located near the Wingecarribee area (**Figure 1**) and general hydrogeological knowledge of this area there are six main groundwater aquifer systems:

1. **Hawkesbury sandstone** – with an average depth of around 150 metres and with variable thickness from 90 to 300 metres, this is the most significant aquifer.

2. **Bulgo sandstone** – has an average depth of about 200 metres and with thickness of about 20 metres.

3. **Scarborough sandstone** – has an average depth of 230 metres and thickness of about 30 metres.

4. **Tertiary basalt** – about 30 metres thick. Rocks provide localised groundwater systems in a series of disconnected aquifers. Groundwater discharge from the base of the basalt layer via seeps and springs provides baseflow to Wingecarribee Swamp and groundwater dependent ecosystems. Recharge is primarily from infiltration of rainfall at outcropping along ridgelines.

5. **Alluvium/colluviums outcrops** – alluvial and colluvial sediments contain small perched groundwater resources which are recharged from rainfall and runoff from the valley sides. Hydraulic conductivity is likely to be high with water moving to either a nearby seep or spring, or directly to the swamp.

6. **Peat swamp deposits** – the depth of peat ranges from 3 to 10 metres. Relatively little is known about the groundwater conditions in the peat. Desiccation cracks formed during the peat swamp collapse have likely increased the porosity of this layer. The swamp receives water from direct infiltration, surface run off and groundwater discharge from the Hawkesbury sandstone or tertiary basalt aquifers.

QUESTION
The Hon. RICK COLLESS: The bores that were drilled for exploratory purposes have since been rehabilitated. Do you have access to the bore log information which would describe the strata and what they found underground as they were drilling, I would assume?
Mr BULLEN: Yes, I would presume so. I will have to take that on notice though.

ANSWER
The SCA has access to most of the exploration bore logs. This information is provided to the SCA in mining and coal seam gas applications. It is also available from the Primary Industries web site:
http://www.dpi.nsw.gov.au/minerals/geological/online-services/minview

There is a requirement that all boreholes drilled for coal mining, mining gas and coal exploration are included in the exploration licences. The bore hole logs and

all geological information can be obtained from the ‘Sydney Basin Reservoir – Prediction Study’ published by NSW Department of Primary Industries in 2008.

Geological cross-sections have been developed by the SCA’s science team and are attached at **Figures 2, 3, 4, 5** and **6**. Location of boreholes in the mining areas is shown in **Figure 7**.

QUESTION
The Hon. Dr PETER PHELPS: What is the smallest dam you have in that southern region?
Mr BULLEN: I would have to take that on notice.

ANSWER
Nepean Dam.

QUESTION
The Hon. SCOT MacDONALD: We visited Camden on Friday and we were told that has been operating for 10 or 15 years. Have you recorded any impact on Sydney's water quality from those activities?
Mr BULLEN: As I outlined to Mr Colless earlier, the Camden gas field is outside the Sydney Catchment Authority's area of operation. In relation to monitoring, we do not do specific monitoring around the AGL project. What we do monitor is the water quality in the upper canal and at this stage—and I would need to double-check this—we have not seen any change in the water quality in the upper canal as a result of the activity.

ANSWER
There have been no impacts on water quality in the Upper Canal from the Camden gas project.

TABLE A General CSG Project Stages

Stages of CSG Project Development (as presented by CSG companies)

1 Consultation
2 Scouting
3 Exploration and pilot programs
4 Construction and production
5 Maintenance and rehabilitation

Exploration to Development Stages

1 Exploration (pre-pilot)
2 Pilot/Appraisal
3 Production

Exploration Phase (pre-pilot)

The exploration phase determines whether the gas resource is economical and if exploration should proceed to field development.

The exploration activities generally include:

- Regional basin studies (desktop);
- Seismic survey;
- Generation of 3D geological models;
- Drilling of several types of exploration holes/wells:
    - core holes (collection of rock samples);
    - stratigraphic holes (open wells for geophysical logging); and
    - exploration wells (design to allow pump testing to determine likely gas and water production volumes).

The purpose of core and stratigraphic bores drilling is to obtain information on:

- Geology - depth and thickness of coal seams (net coal);
- Gas content and composition;
- Gas saturation; and
- Coal seam permeability (down-hole testing).

Each core hole has site specific design. Drilling of cores holes and down-hole testing is usually completed within month or two. When logging and testing is completed, core holes are plugged and abandoned (sealed from the bottom to surface with cement) or capped for potential future use.

Pilot and Appriasal Phase

The purpose of pilot testing (or appraisal testing) is to assess the potential gas reserves in the area and potential environmental impacts. The exploration wells (single or up to 5) produce water and gas and should be fully cased and cemented in place. The casing is perforated at the coal seam to allow the flow of water and gas from the seam. The purpose of pilot/appraisal testing is gathering data on:

- Initial water rates (how much water per day);
- Duration of dewatering and how fast does the rate decline;
- Peak gas rate; and
- Water quality.

Pilot test wells operate for several months (~ 6 to 12) to collect necessary data.

TABLE B

APEX Exploration Drilling Program

Purpose

1 Assess a commercial potential of **goaf gas** extraction accumulated in old mining works

2 Asses **coals seam gas** in unmined coal seams (lower Illawarara seams)

Project involves:

Drilling of 3 types of wells:

14 goaf gas extraction wells located over abandoned mines

2 mine workings to assesing gas in the

2 core holes from unmined coal seams (lower Illavarra seams)

Data collection

geophysical logging, core testing, innitial indication of water production

Timing:

Data collection will take approximatelly one week per well

Other:

Fraccing will not be used

Drilling fluids will contain KCl

TABLE C **RISK CONTROL AND MITTIGATION MEASURES FOR SURFACE AND GROUNDWATER - EXPLORATION PHASE**

Activity	Risk	Cause	Impacts	Risk Rating (un-mined areas)	Risk Rating (mining impacted areas)	Mitigation Measures	Risk Rating post Mitigation and Control
Drilling	Soil errosion	Land clearing	Surface water quality	Low	Low	Errosion and sediment control management plans	Low
	Pollution from drilling fluids/chemical storage	Spill of drilling fluids, seepage from mud pits, tanks	Shallow groundwater and surface water quality	Low	Low	Implementation of chemical control and management plan	Low
		Loss of drilling fluids due to inappropriate drilling assumption, technique or mud composition	Regional groundwater quality	Low	Low	Implementation of industry standards for constructing and abandoning CSG wells (DEEDI, 2011)	Low
	Pollution due to acid rock drainage	Oxidation of sulphidic material present in drill cuttings	Soil and shallow groundwater	Low	Low	Management plan for disposal of drilling waste	Low
	Enhanced aquifer conectivity	Leakage within borehole due to poor well design, construction, completion and abandoment (closure)	Regional groundwater quality	Low/ Medium	Medium	Pressure cemented technique for casing off of overburden formations,	Low
		Compromised well integrity				Ensuring casing integrity and pressure testing	Low
	Gas leak, migration	Poor bore construction	Shallow and regional groundwater quality	Medium	Low	Implementation of industry standards for constructing and abandoning CSG wells (DEEDI, 2011)	Low
	Pollution from fraccing fluids	Spill of fraccing fluids/chemicals	Surface water quality	Medium	Medium	Implementation of chemical control and management plan	Low

Activity	Risk	Cause	Impacts	Risk Rating (un-mined areas)	Risk Rating (mining impacted areas)	Mitigation Measures	Risk Rating post Mitigation and Control
Hydraulic fracturing (if applied)	Pollution from fraccing fluids	Loss of fraccing fluids to the formation, migration of fraccing fluids	Shallow and regional groundwater quality, surface water quality and aquatic ecosystem	Low	Medium	Implementation of monitoring program to characterise the composition of fraccing fluids and monitor impacts on surrounding wells	Low
	Pollution from flowback water (recovered fraccing fluids)	Seepage/ leak of flowback water from the storage pond/tank	Shallow groundwater and surface water quality	Low	Low	Lining of flowback water collection ponds, check integrity of storage tank	Low
	Enhanced aquifer conectivity	Compromised well (casing) integrity	Regional groundwater quality	Low	Low	Ensure casing integrity and pressure testing	Low
		Breach on confining layer (extension of fractures beyond coal seam)				Ensure design of fractures within the seam	Low

DEEDI (Department of Employment, Economic Development and Innovation), 2011. Code of Practice for Constructing and Abandoning Coal Seam Gas Wells in Queensland (November 2011)

TABLE D **RISK CONTROL AND MITTIGATION MEASURES FOR SURFACE AND GROUNDWATER - PILOT TESTING AND PRODUCTION PHASEs**

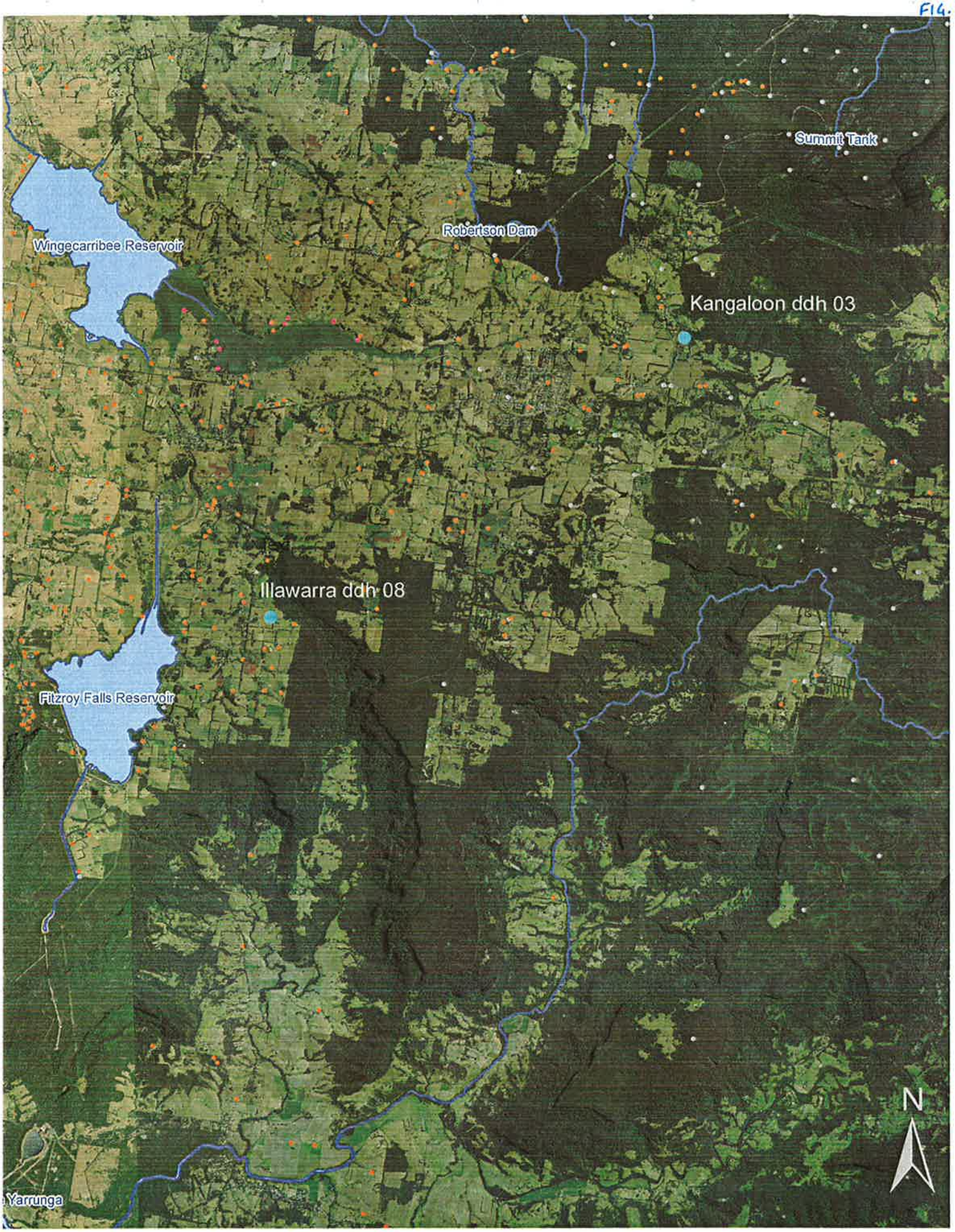
Activity	Risk	Cause	Impacts	Risk Rating (un-mined areas)	Risk Rating (mining impacted areas)	Mitigation Measures	Risk Rating post Mitigation and Control
Depressurisation (dewatering) of coal seams	Pollution from low quality produced water	Spill, leakage from storage of produced water (tank, pit)	Surface water quality	Low	Low	Implementation of produced water management plan	Low
	Leakage between aquifers	Pressure drop in coal seam	Decline in base flow in springs and rivers	Medium	Low	Monitoring surface water, shallow aquifers and setting up trigger levels	Low
			Disconnection of surface and groundwater	Medium	Low		Low
			Loss of available drawdown and potential impacts on nearest groundwater users	Medium	Low		Low
			Regional groundwater quality	Medium	Low	Monitoring regional aquifers and setting up trigger levels	Low
			Change in groundwater flow direction	Low	Medium	Monitoring shallow and regional aquifers and setting up trigger levels	Low
			Reduced groundwater recharge	Low	Low		Low
			Induced gas flow	Medium		Monitoring in place	Medium
			Subsidence	Low	Low	Monitoring in place	Low
		Deterioration of casing, cement stability	Groundwater quality	Medium		Regular inspection of casing integrity and annulus pressures	Low
Gathering system	Uncontrolled discharge of produced water	Leak, break in pipeline	Surface water and shallow groundwater quality	Medium	Medium	Regular inspection of gathering system	Low
		Design, construction of stream crossing, open areas	Surface water quality	Medium	Medium		Low

Activity	Risk	Cause	Impacts	Risk Rating (un-mined areas)	Risk Rating (mining impacted areas)	Mitigation Measures	Risk Rating post Mitigation and Control
Surface infrastructure	Compressor station hazards	Bulk fuel and chemical storage	Contamination of soil, shallow groundwater and surface water	Medium	Medium	Implementation of chemical control and management plan	Low
				Medium	Medium		Low

Notes:

This risk assessment is focused on general CSG activities and does not consider detailed analysis of cummulative impacts of both mining and CSG activities

Impacts of coal seam depressurisation (dewatering) on subsidence will require further assessment. It could be expected that settlement will occur over a much broder area compared to underground mining, however the stresses and strains induced by settlement in coal seams will be significantly lower than in underground mining and less likely coasing fracturing of overlaying strata. Camden project EA did not consider subsidece.



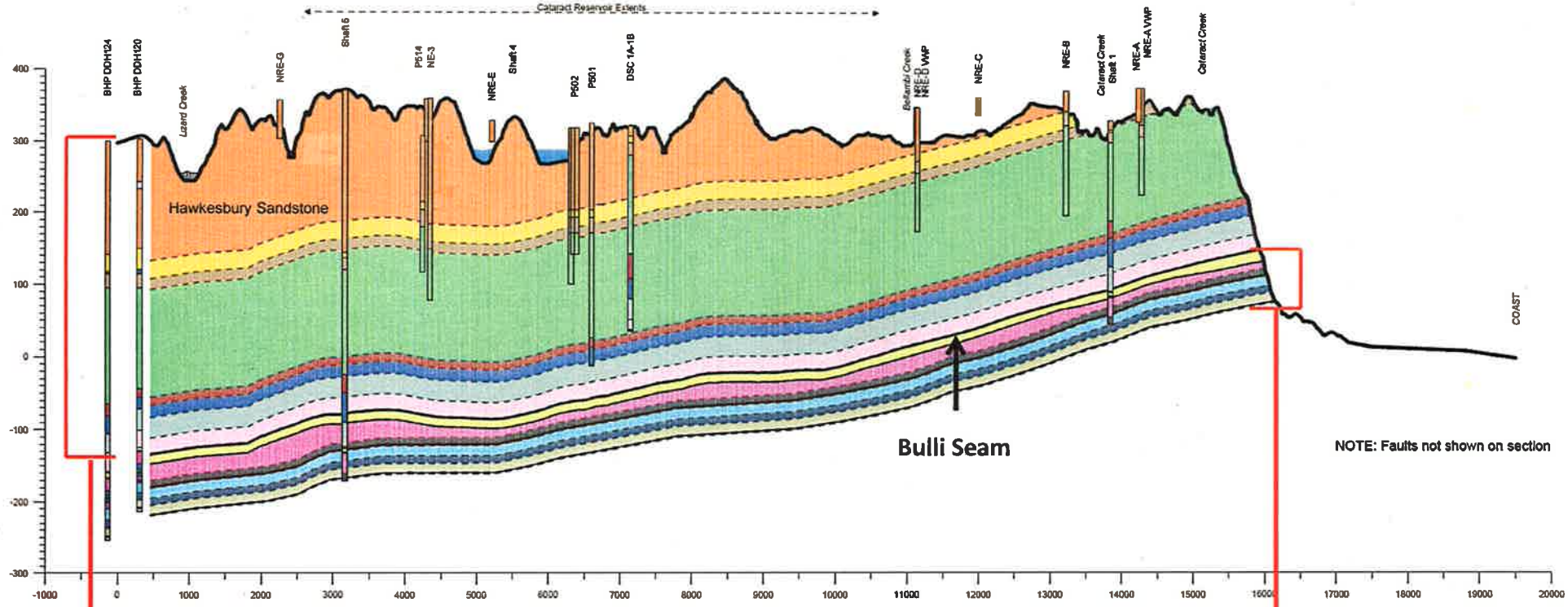
egend

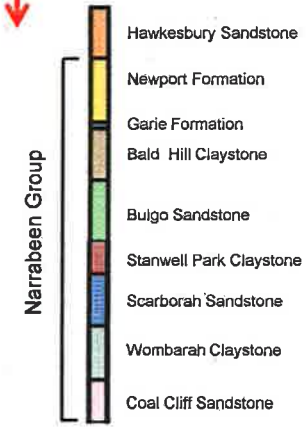
- Registered Groundwater wells (DECC, 2007)
- Exploration Boreholes (Coffey, 2007)
- Exploration boreholes (DPI, 2007)

Fig 1. Location of Boreholes in Wingecarribee Swamp Catchment

2,400 1,200 0 2,400 Meters

FIGURE 2: CONCEPTUAL CROSS-SECTION - NRE No 1 – Gujarad





(modified from Pells Consulting, 2011)

FIGURE 3: CONCEPTUAL CROSS-SECTION – WEST METROPOLITAN AREA

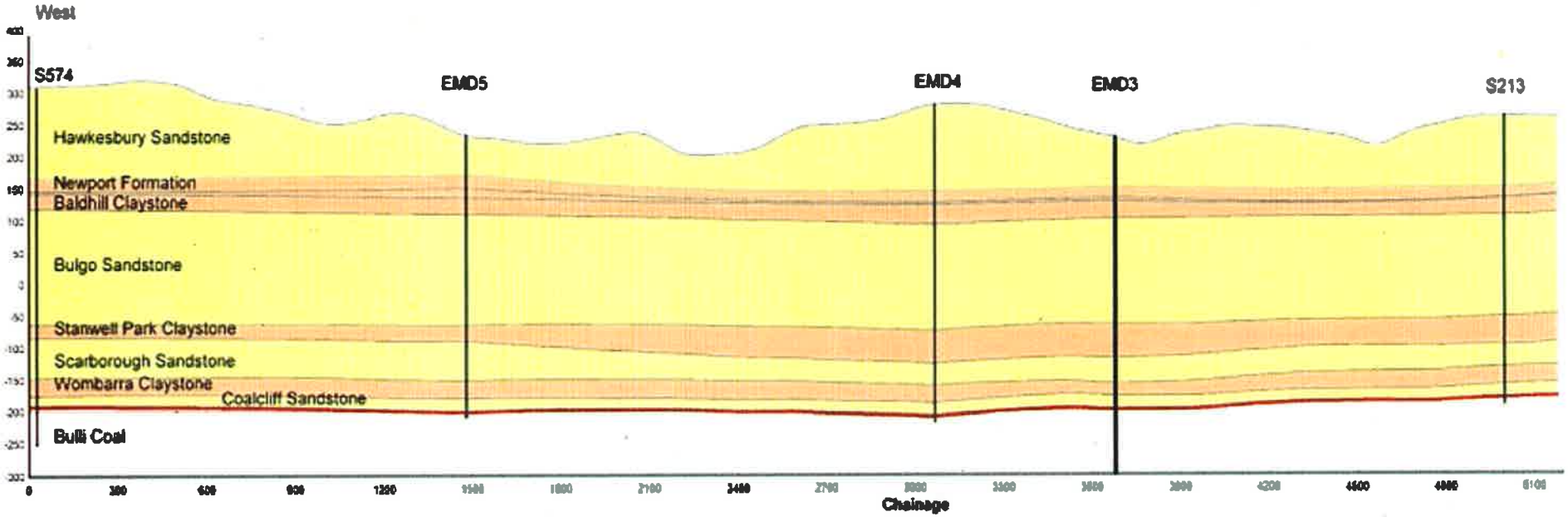


Figure 4

Geology Logs and Coal Seams

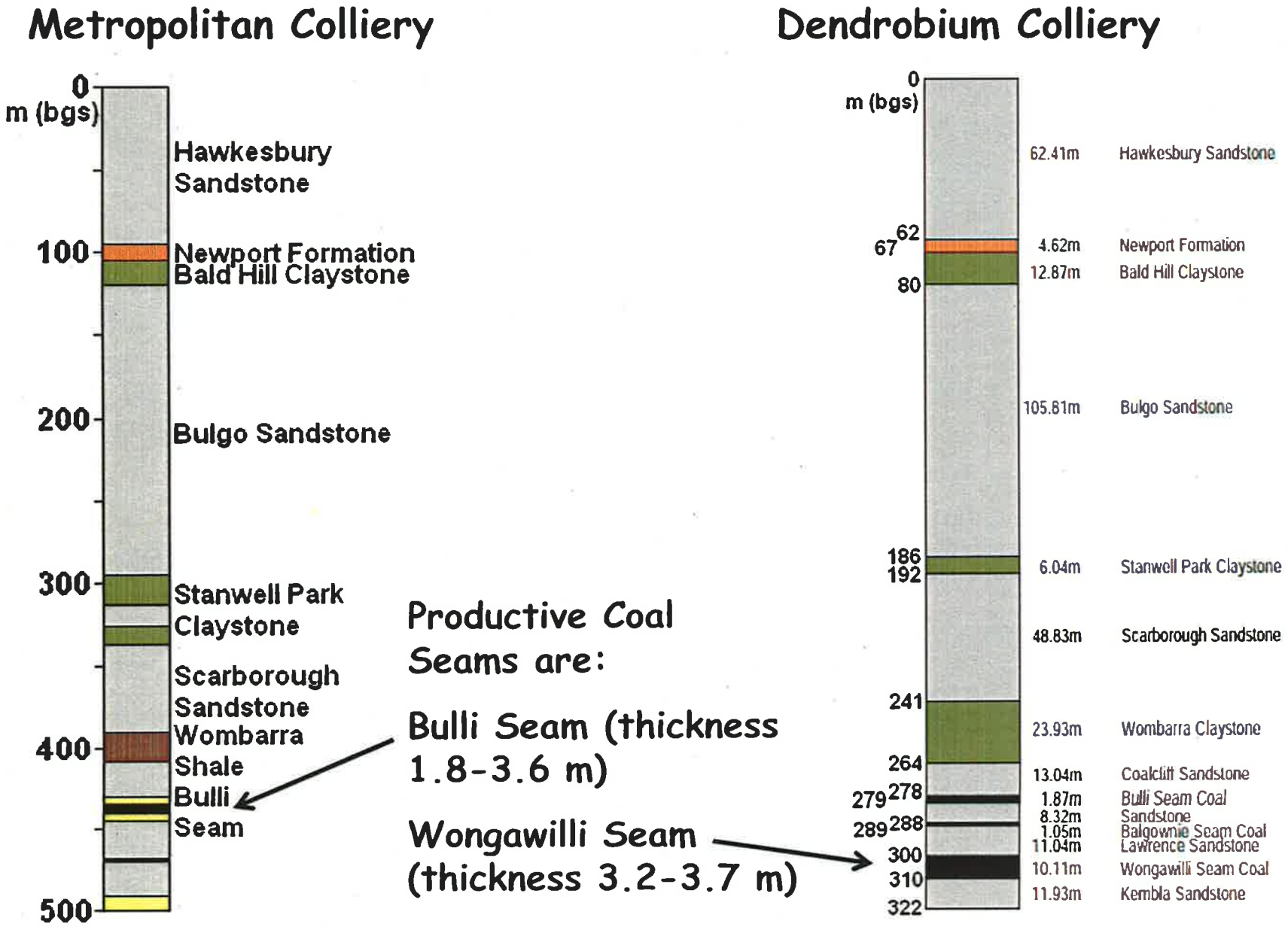


FIGURE 5: CONCEPTUAL CROSS-SECTION – DENDROBIUM

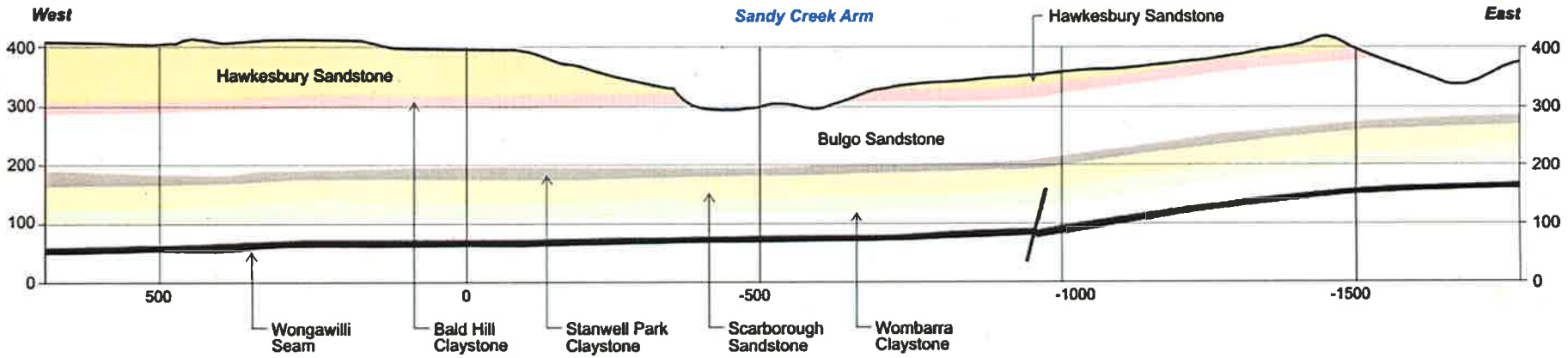
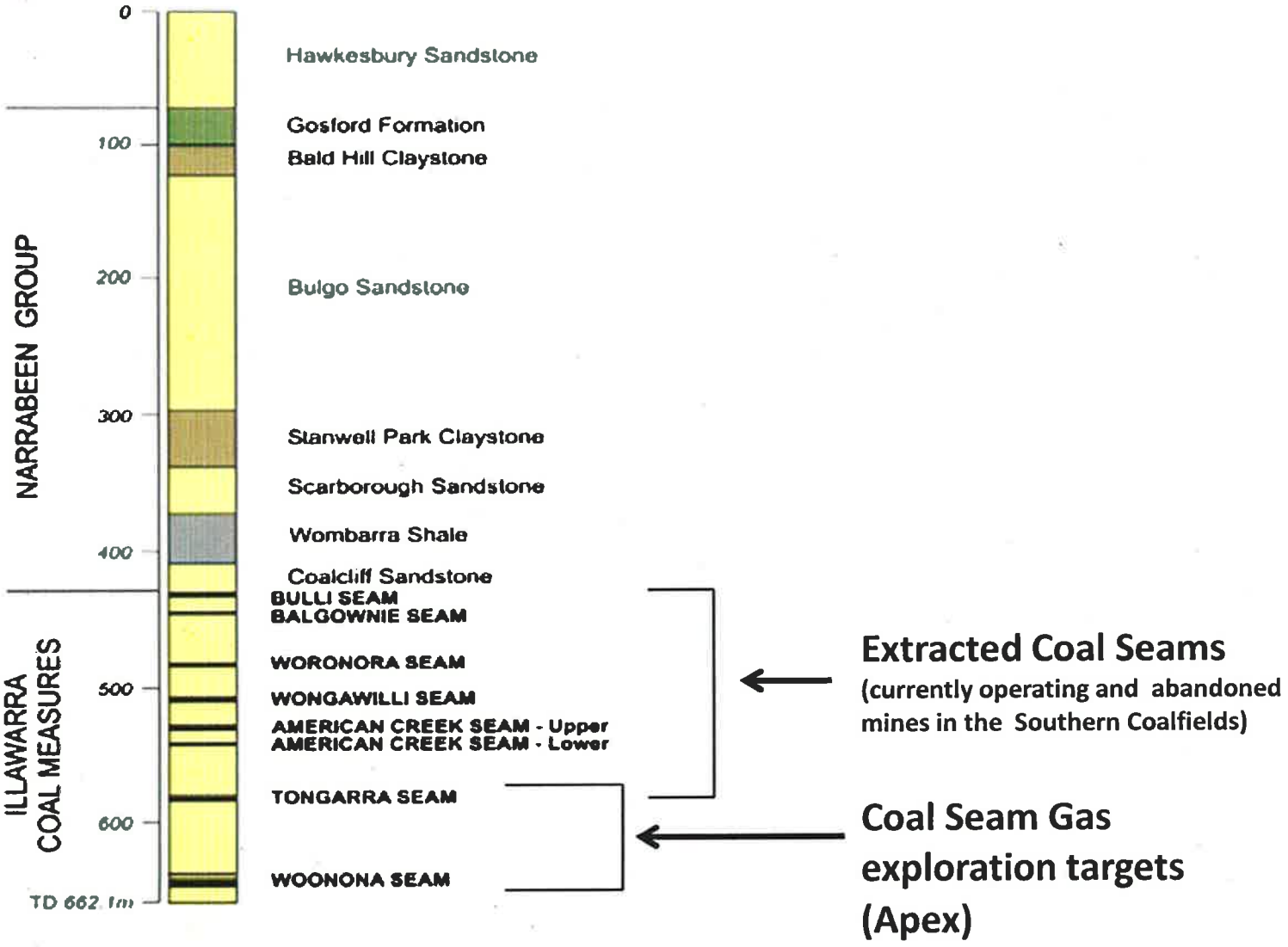
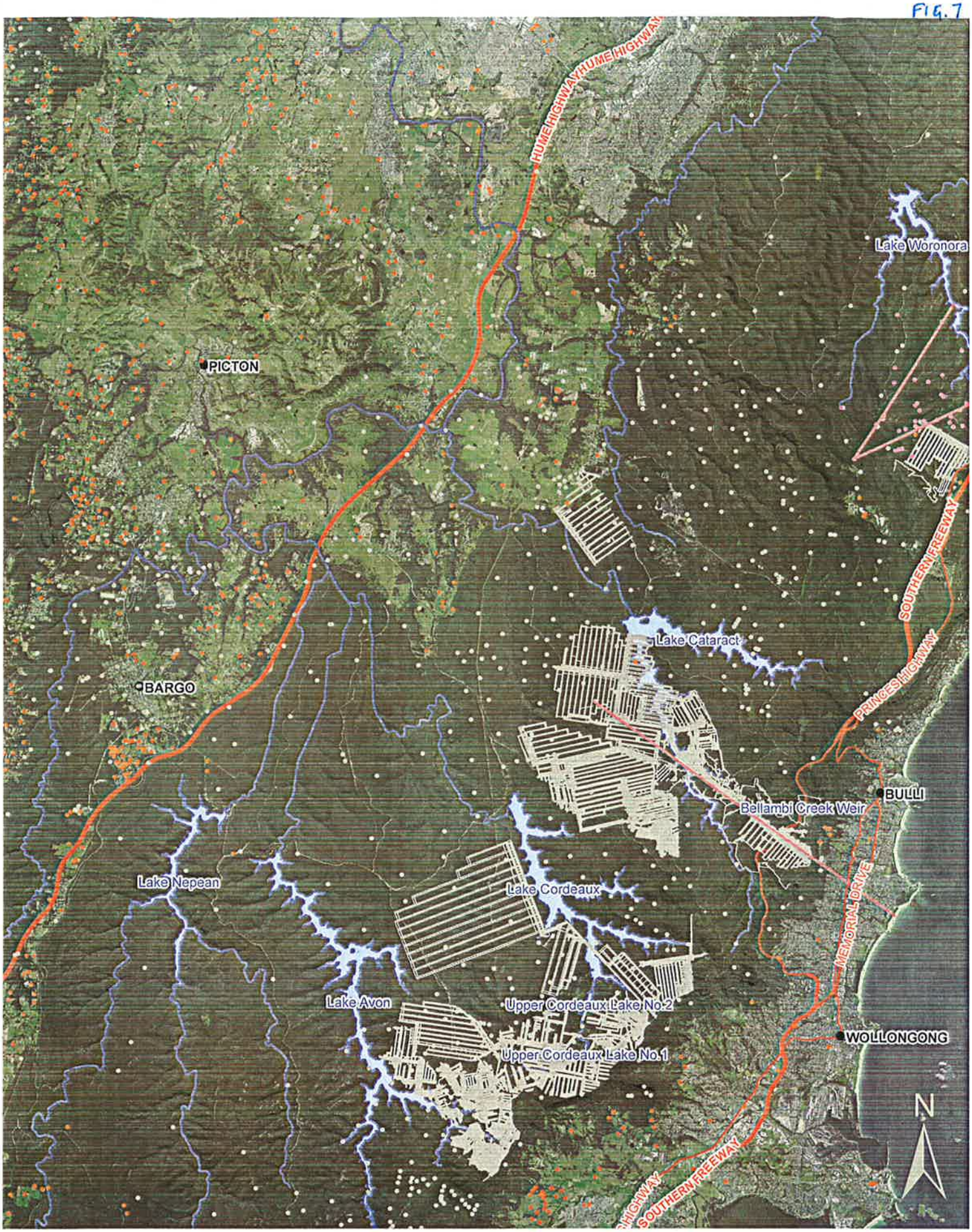


FIGURE 6: SIMPLIFIED STRATIGRAPHIC PROFILE



(modified from Apex, 2009;
Depths are based on data from the exploration borehole DDH3)

FIG. 7



Legend

- Cross-Section
- Groundwater Bore Data (DECC)
- Groundwater_Bore_Data_(Reports)
- Groundwater Bore Data (DPI Study)

Figure 7: Location of Boreholes and Longwall mining areas in the SCA Area of Operations

4,900 2,450 0 4,900 Meters