INDEPENDENT EXPERT ADVISORY PANEL FOR MINING

ADVICE RE:

CHAIN VALLEY CONSOLIDATION PROJECT (SSD-17017460)

GREENHOUSE GAS ASSESSMENT

January 2024

Advice No: IEAPM 202401-1

EXECUTIVE SUMMARY

This advice report has been prepared by the Independent Expert Advisory Panel for Mining ('the Panel') in response to a request from the Department of Planning and Environment ('the Department') in relation to greenhouse gas emissions associated with the Chain Valley Colliery Consolidation Project ('the Project') proposed by Great Southern Energy Pty Ltd (trading as Delta Coal).

The Project aims to consolidate the existing Chain Valley Colliery and Mannering Colliery operations under a single approval and to extend life of underground mining operations by two years to 2029, resulting in approximately 9.5 Mt of additional Run-of-Mine (ROM) coal production.

The Department requested that *the Panel undertake a comprehensive review of the greenhouse gas assessment completed for the Chain Valley Consolidation Project including:*

- *Consideration of whether the calculations (including the assumptions used) are reasonable, appropriate, and suitably justified.*
- *Identification of any areas of deficiency and recommendations to improve or resolve these issues in the assessment.*
- *Suitability and adequacy of the proposed mitigation and/or management and/or protection measures to avoid, mitigate or minimise the likelihood, extent, and significance of impacts.*
- *Consideration and recommendation of any additional measures to further avoid, minimise and/or mitigate any identified impacts of the project; and*
- *Any recommendations (if required) for additional information to inform the assessment of the Project.*

The Panel's response is confined to Scope 1 fugitive emissions directly associated with the mining process. These fall into the following three categories:

- Underground emissions from active mining areas ('ROM emissions')
- Ongoing underground emissions from previously extracted areas ('legacy emissions')
- Surface emissions from coal between the time when it exits the mine portal and when it is transported off site ('stockpile coal').

The majority of emissions are from previously extracted areas. The greatest potential for reducing emissions will be realised in better controlling these 'legacy emissions'.

The Panel concludes that:

1. The overall historical emissions assessment is adequate
2. The breakdown between legacy emissions and ROM emissions is relevant and important, but the methodology of basing it upon a static gas content value is flawed.
3. The forecast assessment is based upon this flawed methodology and also fails to take account of changes in the gas reservoir properties across the future mining areas.
4. It is not clear if gas emission from stockpiled coal is included in the assessment.

Assessment of greenhouse gas emissions (GHGE) for the Project is in its early stages and there are shortcomings. In particular, the Panel recommends that future assessments should include:

1. Mapping the GHGE footprint, which should include differentiating between legacy emissions, ROM emissions and stockpile emissions. For legacy emissions, this means underground surveys to quantify the type of gas (CH_4 or CO_2), and where it enters the ventilation stream. ROM emission assessment requires monitoring and analysis of return CH_4 and CO_2 quantities for each mining area to quantify changes in gas generated as a function of coal production ("gas make" assessment). Stockpile coal emissions should be based on measurement of gas content and composition at the time that coal exits the underground mine workings and again as it exits the mine site.
2. Assessing the gas reservoir size in current and future mining areas. This necessitates additional gas content and composition testing.
3. Generating a stand-alone Greenhouse Gas Management Plan (GHGMP). The current plan for the Delta Coal Project is embedded in the Air Quality and Greenhouse Gas Management Plan and lacks adequate detail. The GHGMP should incorporate and expand upon the preceding points 1) and 2) and provide links to specific studies to be undertaken to give effect to these. Mitigation measures can then be better prioritised and designed and incorporated in the GHGMP.

Further (and not only in relation to this Delta Coal Project):

4. The Panel acknowledges that the National Greenhouse Accounts reporting stipulates a fixed "emissions factor" (EF) for the assessment of stockpile gas emission. However, the Panel is of the view that this approach and value, which dates back some 15 years, is now inadequate for properly identifying and managing GHGE and that, going forward, these stockpile emissions should be measured directly.

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1.0 INTRODUCTION

Chain Valley Colliery (CVC) and Mannering Colliery (MC) are underground coal mines, owned and operated by Great Southern Energy Pty Ltd (trading as Delta Coal). Delta Coal is a wholly owned subsidiary of Delta Electricity Pty Ltd which owns and operates the Vales Point Power Station (VPPS).

On 23 June 2023, the Department of Planning and Environment ('the Department') requested advice from the Independent Expert Advisory Panel for Mining ('the Panel') on greenhouse gas emissions associated with the proposed Chain Valley Colliery Consolidation Project ('the Project'). The Project allows for consolidation of the existing CVC and MC operations under a single approval and an associated two year extension of the life of mine operations to 2029, resulting in the additional recovery of approximately 9.5 Mt of Run-Of-Mine (ROM) coal.

The Department requested that *the Panel undertake a comprehensive review of the greenhouse gas assessment completed for the Chain Valley Consolidation Project including:*

- *Consideration of whether the calculations (including the assumptions used) are reasonable, appropriate, and suitably justified.*
- *Identification of any areas of deficiency and recommendations to improve or resolve these issues in the assessment.*
- *Suitability and adequacy of the proposed mitigation and/or management and/or protection measures to avoid, mitigate or minimise the likelihood, extent, and significance of impacts.*
- *Consideration and recommendation of any additional measures to further avoid, minimise and/or mitigate any identified impacts of the project; and*
- *Any recommendations (if required) for additional information to inform the assessment of the Project.*

The Chair of the IEAPM (Em. Professor Jim Galvin) convened the following Panel for this purpose:

- Em. Professor Jim Galvin – Chair
- Prof. Dianne Wiley
- Dr Ray Williams

The Panel's response is limited to Scope 1 fugitive emissions directly associated with the mining process. These comprise:

- Emissions during active mining
- Emissions from underground, previously mined areas
- Emissions from coal once it exits the mine portal and prior to shipment off site (stockpile coal).

2.0 METHOD OF OPERATION

The Department's request letter of 23 June 2023 contained links to:

- Chain Valley Consolidation Project Environmental Impact Statement, report 20170/R09 September 2022 prepared by Umwelt (Australia) Pty. Ltd. (Umwelt)
- Appendix 14 Greenhouse Gas and Energy Assessment, Chain Valley Consolidation Project, report 21106/R01 July 2022 prepared by Umwelt
- Chain Valley Colliery Consolidation Project Submissions Report, report 20170/R08 March 2023 prepared by Umwelt

The Panel and the Department convened on the 3 July 2023 and 13 July 2023 and from those meetings, further documentation was provided, the most relevant being the CVC and MC Air Quality and Greenhouse Gas Management Plan (AQGHGMP). The Panel provided Delta Coal with a list of questions on 13 July 2023.

Delta Coal provided its response to the questions on 23 October 2023 and a meeting was held between Delta Coal, the Department and the Panel on 24 October 2024. From this meeting, some follow-up questions were sent to Delta Coal on 25 October 2023. Responses to these questions were received on 16 November 2023.

3.0 BASIC MINE GAS TERMINOLOGY AND PRINCIPLES

The following basic terminology and principles associated with gas emissions and gas management in underground coal mining operations is provided to aid the layman in understanding the Panel's advice report.

3.1. GAS CONTENT

Unlike conventional natural gas reservoirs where gas is stored in the pores of rocks, gas in coal is stored in an almost totally adsorbed state. That is, it is chemically bound to the coal and does not exist in gaseous form. When the surrounding pressure is relieved sufficiently by actions such as mining and pre- or post-mining gas drainage, the gas within coal can begin to desorb. This is a relatively slow process that can take hours to years, depending upon the properties of the coal – in particular the lump or particle size. A 50 mm lump of coal can take months to fully desorb its gas.

The adsorbed gas is usually CH_4 or CO_2 or a combination of both. The gas adsorption characteristics differ markedly according to gas type, as does the speed of gas desorption. In lump coal freed upon mining, CO_2 will desorb more quickly than CH_4 – other things being equal.

An important gas reservoir parameter is gas content, which is a measure of the quantity of gas adsorbed in the coal per unit mass. It is only stored in the carbonaceous component of the coal. Coal also consists of varying amounts of moisture and mineral matter and these components do not store gas.

Gas content is expressed in units of cubic metres of gas per tonne of coal (m^3/t) and it is fundamentally important when characterising and reporting this gas content to relate it to the associated mineral matter and moisture content of the coal, particularly the former. Mineral matter is characterised by the relative density of the coal (being weight per unit volume, usually reported as grams per cubic centimetre – g/cc, or tonnes per cubic metre - t/m^3) and/or the ash (%) content of the coal, the latter being the residue after combusting the coal at a high temperature in air.

The importance of relating gas content to the mineral content and moisture content is illustrated by the following simple example. For an equivalent volume of coal, a gas content of 5.3 m^3/t for a coal with 12.9% ash is equivalent to a gas content of 4.6 m^3/t for a coal with 23% ash for the same level of moisture.

3.2. GAS MIGRATION AS A RESULT OF MINING

Mining depressurises and breaks up the coal, thus allowing gas to desorb. It is convenient to differentiate between gas desorbed essentially at the time of mining ("active mining areas"), longer-term gas desorption/migration from previously mined areas ("legacy gas"), and gas desorbed from mined coal after it reaches the surface ("stockpile gas").

The volume and concentration of "active mining area" gas and the "legacy gas" are combined in the mine ventilation air and are measured from the gas concentration and air quantity exiting the mine via the ventilation system. Distinguishing between these two components is required to adequately assess the greenhouse gas footprint. The boundary between them is defined by the gas exiting the "active mining area/s".

In the "active mining area", gas is emitted from the solid coal seam as roadways are being mined through it and from the broken coal that has been mined. In situations where mining results in caving of the roof strata and/or fracturing of the floor strata (e.g. pillar extraction and longwall mining), depressurisation and fracturing of the roof and/or floor strata can result in the release of significant additional volumes of gas, especially if other coal seams exist within these affected zones.

The total gas released in the "active mining area" is best described by the "gas make" curve, which defines the relationship between gas evolution and coal production for a given set of geological and gas reservoir conditions. This is illustrated in Figure 1, which shows that while more gas is produced with higher rates of coal production, the quantity of gas produced per tonne of coal mined ("gas make") is less. This reflects the time dependent nature of gas release. Gas continues to desorb from solid coal in the active mining area after mining ceases or reduces, resulting in an increasing gas make per tonne of coal mined with decreasing coal production.

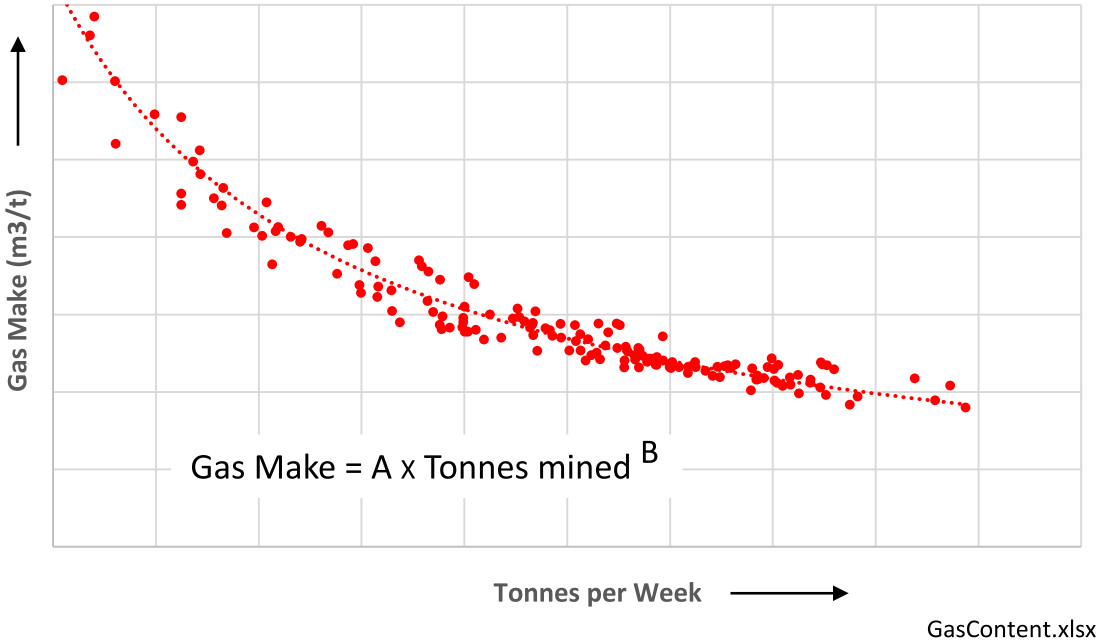

Figure 1: An example of a relationship between gas make and coal mined for the "active mining area"

"Gas make" has the same units as gas content – m^3/t, but is quite different. Gas content is a measure of the quantity of gas in a discrete block of coal, while gas make represents the gas partially liberated from mined coal and from solid coal surrounding and in proximity to the mined area. "Gas make" is usually a higher number than gas content.

"Legacy gas" continues to pollute the mine roadways in the older regions outside the "active mining area/s". For older mines with extensive workings, this gas can constitute the bulk of greenhouse gas emissions. It is mostly made up of gas leaking from old areas that have been attempted to be sealed off (isolated from the mine ventilation network). The greenhouse gas composition of legacy gas is quite different to that of active mining emissions, usually exhibiting higher proportions of CO_2 relative to CH_4. For equivalent gas contents, CH_4 has a much higher desorption pressure than CO_2 resulting in earlier loss of CH_4 relative to CO_2 from solid coal. This process is in contrast to the faster rate of desorption of CO_2 from lump coal.

On reaching the surface, the coal can still contain significant quantities of adsorbed gas that continue desorbing into the atmosphere while the coal is on site ("stockpile gas"). The actual quantity of gas retained in the coal at the time that it reaches the surface can be highly variable, depending (among other things) upon whether the coal has been predrained (ie had its gas content reduced by gas drainage drilling prior to mining) and on the gas type (proportions of CH_4 and CO_2).

4.0 GREENHOUSE GAS ASSESSMENT

The main document on which this Panel advice is based is *Appendix 14 Greenhouse Gas and Energy Assessment (GHGEA) July 2022*. This GHGEA aims to address the Secretary's Environmental Assessment Requirements (SEARs) requiring "an assessment of the likely greenhouse gas impacts of the development". The "Emission Assessment Methodology" gives a high-level explanation on the approach used, with reference to National Greenhouse Accounts (NGA) accounts and emission factors documentation for added credibility. It is, however, light on with detail, leaving the reader to either accept the results or to try and recreate them in order to understand and verify their derivation. The Panel has endeavoured to undertake the latter.

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2.4 Emission Assessment Methodology

The GHGEA framework is based on the methodologies and emission factors contained in the National Greenhouse Accounts (NGA) Factors 2020 (DISER 2020) (the NGA Factors). The assessment framework also incorporates the principles of The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (WRI/WBCSD 2004) (the GHG Protocol).

The GHG Protocol provides an internationally accepted approach to greenhouse gas accounting. The GHG Protocol provides guidance on setting reporting boundaries, defining emission sources and dealing with issues such as data quality and materiality.

Scope 1 and 2 emissions were calculated based on the methodologies and emission factors contained in the NGA Factors 2020 (DISER 2020) and NGA Factors 2021 (DISER 2021). Consistent with the National Inventory Report, ventilation fugitive emissions were forecast using an implied emissions factor, which was derived from site specific National Greenhouse and Energy Reporting data. Due to the ongoing emissions from old workings which form part of the CVC and MC operations, the estimates of Scope 1 emissions have taken into consideration these annual legacy emissions and future emissions from ROM coal extracted. The estimates of emissions associated with ROM coal extraction also utilise site specific gas content data for the target seam.

In establishing its calculation methodology, Umwelt (Australia) Pty Limited (Umwelt) distinguishes between "legacy fugitive emissions[1]" and "ROM fugitive emissions[2]". The sum of these is presumably the total fugitive emissions leaving the mine ventilation system.

The ROM fugitive emission component to the total fugitive emission is calculated from a Fassifern seam gas content of 5.3 m^3/t at 97% CH_4 and 3% CO_2. Details of the calculation are not provided, but in order to try to understand how it was derived, a check calculation has been undertaken by the Panel for FY2021/2022 (page A-2, Appendix A of the Appendix 14 document).

[1] Emissions from non-active mining areas – unrelated to coal production rate

[2] Emissions from active mining areas – directly related to coal production rate

From Umwelt table on page A-2

- ROM tonnes 1,489,783.14
- Revised Fugitive Emissions Estimate 499,706.60 t CO_2 e
- Historical Fugitive Emissions from ROM 145,925 t CO_2 e …..*Val 1*

The check calculation[3] produces a value for historical fugitive emissions of 146,039 t CO_2 e ….*Val 2*

There is a small difference between the check calculation *Val 2* and the Umwelt value *Val 1*. The check calculations for each year produce the same emissions factor (EF) as reported by Umwelt (ie 0.098 = 146,039/1,489,783.14).

Umwelts legacy fugitive emissions are approximately the difference between the total emissions and the ROM emissions. There is a small difference though, which is unexplained.

[3] Check calculation of Historical Fugitive Emission from ROM (temperature 15ºC and 101.3 kPa)

- Volume CO_2 = 236,876 m^3 **(A)** - from ROM tonnes * 5.3 m^3/t *3% CO_2 gas concentration
- Volume CH_4 = 7,658,975 m^3 **(B)** - from ROM tonnes * 5.3 m^3/t * 97% CH_4 gas concentration
- Tonnes of CO_2 = 469 - from **(A)** * 1.98 kg/m^3/1000
- Tonnes of CH_4 = 5,199 - from **(B)** * 0.6788 /1000 which gives
- 145570 t CO_2 e when multiplied by the Global Warming Potential (GWP) for CH_4 of 28.
- Total CO_2+CH_4 emission is 469+145,570 = 146,039 t CO_2 e …..*2*

5.0 CRITIQUE OF APPROACH USED

5.1. BREAKDOWN BETWEEN ACTIVE MINING AND "LEGACY" MINING AREAS

The total emissions from the mine are well known from continuous/regular monitoring of air quantities and gas concentrations in the main ventilation return entries (shafts). In contention is the breakdown between emissions from the active mining areas and those from previously extracted areas. Using a Fassifern seam gas content value (5.3 m^3/t) in this way i.e. assuming all gas will desorb from coal cut in the active mining area, is technically incorrect. Probably half the adsorbed gas will still remain in the coal when it exits the mine portal.

Making the distinction between emissions from active mining areas and legacy mining areas is sound, but based on the approach adopted in the GHGEA, the different components remain undefined. The Panel considers that the following would provide a more robust approach with internal consistency checks:

1. At a high level, examine the trend of upcast shaft emissions. Relatively long periods of zero production would define a base level, background emission that essentially reflects the gas contribution from the previously mined areas. That baseline can then be subtracted from the total emission to obtain a value of active mining area gas emission.
2. Review real time gas analysis (including tube bundle data) from the return airways (exits) of each current active mining panel. Use monthly ventilation surveys to indicate air quantities. This should enable relationships to be determined between gas make (in m^3/t) and production rate. The gas make curves from each active mining area can be compared and related to basic gas reservoir properties to enable forward assessment of gas emissions.
3. The assessment of active mining emissions from points 1. and 2. above can be compared for internal consistency.

The gas concentration exiting the mine portal is different to that determined from gas content testing:

- For CVC ventilation fan data 0.49% CH_4, 0.11% CO_2 - CH_4/CH_4+CO_2 = 0.82
- For gas content testing 97% CH_4, 3% CO_2 air and N_2 free – CH_4/CH_4+CO_2 = 0.97

The assessment above will need to quantify CH_4 and CO_2 concentrations at each location and changes with time. The higher proportion of CO_2 in the CVC ventilation fan data reflects the higher desorption pressure CH_4 has compared to CO_2, resulting in preferential bleeding of CH_4 and relative enrichment of CO_2 in the remaining adsorbed gas.

The Umwelt documents[4] do not clearly state if gas emissions from stockpile coal have been calculated. The National Greenhouse and Energy Reporting (Measurement) Determination 2008[5] provides for an emissions factor (EF) of 0.019 tonnes CO_2 e/tonne of raw coal to cover post mining activities (such as emission from stockpiles) for gassy mines[6].

While use of an EF to estimate stockpile emissions is simple and stipulated, the Panel is of the view that such emissions can and should be determined directly. Stockpile emissions are a function of:

- The gas content and composition of the coal as it exits mine portal
- The time in stockpile before shipment off site
- The moisture content of the coal
- The particle size and inherent desorption rate characteristics of the coal

[4] It is included in the NGE reports
[5] Compilation 14, 1 July 2022, page 114
[6] A mine has to have at least 0.1% CH_4 in the return ventilation for it to be classified as gassy.

An EF is a blunt instrument, similar to using an EF for characterising emission from open cut coal mining. Measurement would involve gas desorption testing of coal leaving the mine portal and leaving the mine site.

5.2. FORWARD ASSESSMENT

Umwelt's forward assessment of GHGE for ROM coal is based upon the previously calculated EF of 0.098 t CO_2 e/ROM t, meaning that additional ROM production of 9,488,627 t is predicted to result in an additional 929,413 t CO_2 e of GHG emissions (9,488,627* 0.098 = 929,413).

For the legacy fugitive emissions, the assessment is the average of previously reported emissions (515,348 t CO_2 e) per annum, multiplied by the two year extension (giving 1,030,697 t CO_2 e).

The prediction is firmly based on the future mining environment being the same as the past environment, with adjustment only for production rate and no accounting for any change in gas reservoir properties. Given it is looking forward only two years, such an extrapolation may well be reasonable but needs to be justified in the assessment. However, the methodology separating ROM tonnes from legacy tonnes is flawed.

If the forward estimate is based solely on total mine emissions, ignoring the break down between ROM coal and legacy emissions, it produces an EF of 0.532 t CO_2 e/ROM t. This results in a much greater emission from additional mining (9,488,627 t ROM * 0.532 = 5,049,119 t CO_2 e, compared to 1,960,110 t CO_2 e from 929,413 + 1,030,697).

The greater the amount of gas assigned to ROM tonnage, the lower the total emissions – hence the importance of correctly apportioning emissions between legacy and ROM tonnes.

6.0 AN ALTERNATIVE APPROACH

6.1. GAS CONTENT AND RESERVOIR SIZE

The Fassifern Seam in situ gas content value of 5.3 m^3/t at 97% CH_4 and 3% CO_2 is central to Umwelt's forward assessment. It appears to be the result of gas content testing from sample CV0036, the most recent and highest value from testing of the Fassifern seam (see Figure 2 and Table 1).

The gas content testing was undertaken by GeoGAS Pty Ltd.[7] from cores samples taken from underground. Samples CV0001 to CV0025 come from a down-hole covering seams below the Fassifern Seam. Samples CV0026 to CV0036 are from in-seam cores in the Fassifern Seam.

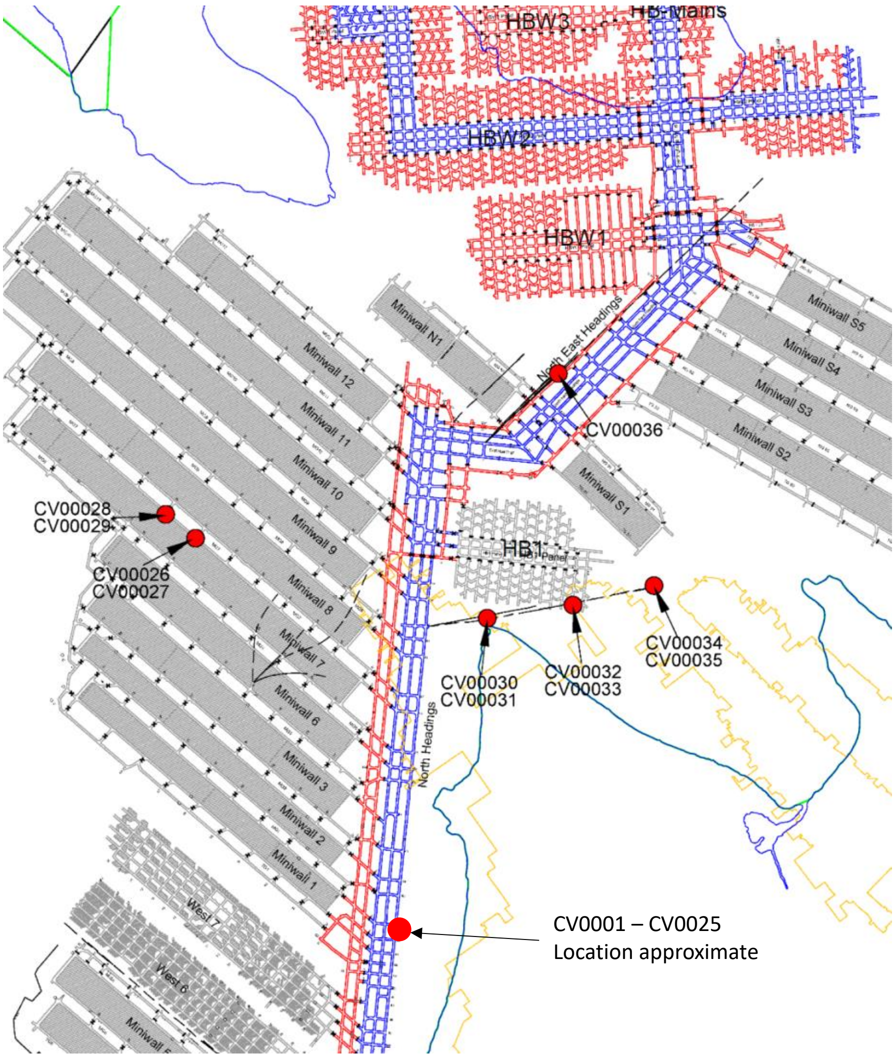

Figure 2: Gas Content Sample Locations from the Fassifern Seam, Chain Valley Colliery.

[7] GeoGAS Reports 2017-1494 January 2018, 2017-1480 October 2017. In report 2017-1494 test validation includes earlier gas content data – these need to be sourced and added to the database

Table 1: Gas Content Test Results

GeoGAS Sample No	Seam	Depth Along Borehole From (m)	Depth Along Borehole To (m)	Thick-ness (m)	Qm @ Sample Ash (m3/t)	CH_4 /CH_4+CO2	RD (g/cc)	Ash (%)
CV0001	Lower Pilot	132.14	132.66	0.52	3.21	0.91	1.59	39.6
CV0002	Floraville	136.85	137.58	0.73	2.58	0.92	1.92	61.3
CV0003	Floraville	139.1	139.75	0.65	4.33	0.94	1.46	24.3
CV0004	Floraville	139.94	140.67	0.73	1.92	0.91	1.86	59.6
CV0005	Hartley Hill	183.51	184.11	0.6	3.66	0.92	1.67	43.8
CV0006	Hartley Hill	184.37	184.85	0.48	4.07	0.93	1.41	21.1
CV0007	Hartley Hill	184.85	185.55	0.69	3.98	0.92	1.55	34.6
CV0008	Hartley Hill	185.55	186.3	0.75	3.92	0.92	1.44	21.5
CV0009	Australasian	198.65	199.35	0.7	2.39	0.91	1.72	48.4
CV0010	Australasian	199.35	199.91	0.56	3.25	0.92	1.84	57.9
CV0011	Australasian	200.02	200.72	0.7	2.42	0.91	1.91	60.9
CV0012	Australasian	200.72	201.47	0.75	1.93	0.9	2.01	68.2
CV0013	Australasian	201.47	202.23	0.76	2.31	0.93	1.86	58.6
CV0014	Australasian	202.23	202.92	0.69	2.29	0.91	1.95	65.4
CV0015	Australasian	203.09	203.79	0.7	2.30	0.93	1.85	55.3
CV0016	Australasian	203.79	204.52	0.73	4.72	0.93	1.51	29.7
CV0017	Australasian	204.52	205.07	0.55	6.04	0.93	1.38	16.4
CV0018	Montrose Upper	210.75	211.15	0.4	4.76	0.95	1.44	24.3
CV0019	Wave Hill	252.88	253.44	0.56	4.22	0.92	1.5	34.9
CV0020	Wave Hill	253.54	254.06	0.52	5.27	0.95	1.44	20.8
CV0021	Wave Hill	256.14	256.89	0.75	4.92	0.96	1.57	35.3
CV0022	Wave Hill	256.89	257.57	0.68	5.96	0.95	1.43	23.6
CV0023	Fern Valley	258.96	259.39	0.43	3.97	0.96	1.65	40.6
CV0024	Fern Valley	260.59	261.33	0.74	4.79	0.96	1.54	35.3
CV0025	Fern Valley	261.33	261.98	0.65	4.10	0.96	1.71	48.8
CV0026	Fassifern	0.7	1.5	0.8	5.00	0.98	1.4	13.4
CV0027	Fassifern	1.5	2.2	0.7	4.61	0.98	1.42	16
CV0029	Fassifern	1.78	2.46	0.68	2.97	0.93	1.39	12.5
CV0030	Fassifern	149.59	150.34	0.75	3.82	0.98	1.7	41.3
CV0031	Fassifern	150.34	151.09	0.75	4.26	0.94	1.4	12.9
CV0032	Fassifern	400.54	401.29	0.75	5.37	0.98	1.45	12.1
CV0033	Fassifern	401.29	402.04	0.75	4.50	0.98	1.41	11.3
CV0034	Fassifern	640	640.75	0.75	4.53	0.96	1.52	19.6
CV0035	Fassifern	640.75	641.5	0.75	4.68	0.96	1.47	16.9
CV0036	Fassifern	309	N/A	N/A	5.29	0.97	1.42	12.9

While these data are high quality, there is a tendency to sample lower ash coal than is typical for the seam as a whole. For example, sample CV0036 with a gas content of 5.29 m^3/t has a corresponding ash of 12.9%. The full seam at this location has an ash of 23.4%[8]. To correctly apply a gas content value, it must be corrected to the ash (or relative density RD) of the region of interest. Correcting the 5.29 m^3/t gas content to 23.4% gives a value of 4.64 m^3/t (see Figure 3).

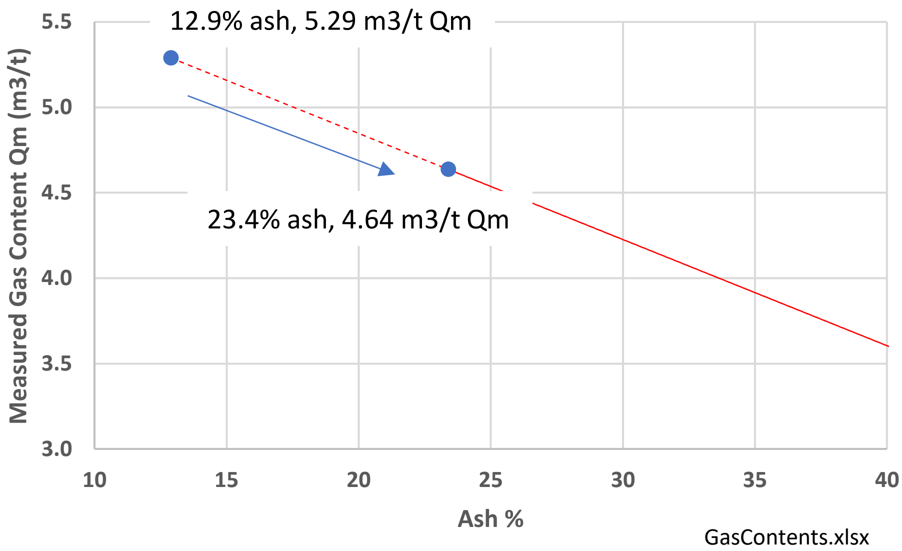

Figure 3: Correction of gas content value from sample ash to seam ash

Three regions (1 to 3 in Figure 4) are proposed to be mined in the Fassifern Seam. For each region[9], the gas content, seam ash, relative density (RD) and seam thickness can be defined.

Utilising these values, the gas reservoir size (GRS) is defined as:

GRS (m^3/m^2) = Full seam thickness (m) * Full seam RD (t/m^3) * Gas content[10] at seam RD (m^3/t)

The most uncertain of these parameters is gas content, but the data are usable by taking into account the variation that would occur when corrected to seam ash in each region.

Data from the borehole drilled below the Fassifern seam (CV0001 to CV0025) are potentially usable. It shows a consistent change with ash and depth along the borehole below the Fassifern Seam (see Figure 5).[11]

With zero depth below the Fassifern Seam and at the seam ash at the borehole location (22.2%), the calculated gas content is 2.9 m^3/t. It appears Region 2 may have a significantly lower gas content than Regions 1 and 3. Further gas content testing should be done to better define these regions.

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[8] Fassifern Seam Ash Content plan, last page file *231107 IEAPM V2 Information Request - Delta Coal Response.pdf*
[9] Region 1 probably warrants two sub regions
[10] Measured gas content Qm should be converted to Absolute Gas Content Qt at seam RD and ash

[11] Relationship described by:

Calculated Qm = Depth along borehole (m) * 0.009514 + Ash (%) * -0.06115 + 4.303918

With a low standard deviation of 0.47 m^3/t.

Figure 4: Proposed mining regions in the Fassifern Seam

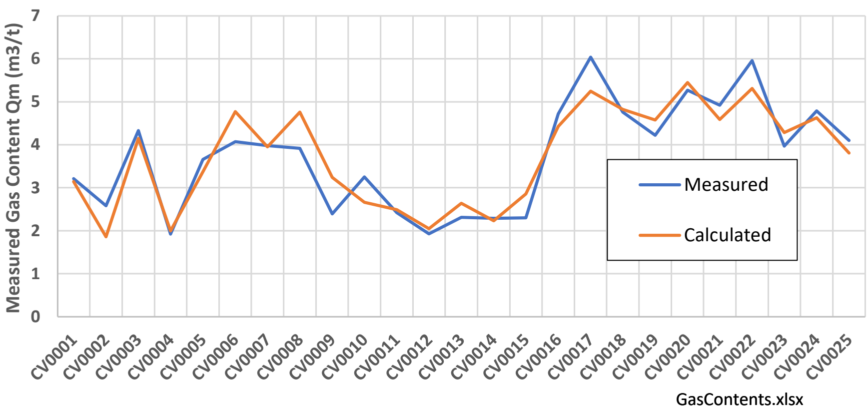

Figure 5: Measured and calculated gas content for borehole drilled below the Fassifern Seam

As an example, assigning seam thickness, ash (RD) and gas content to each region produces the indicative gas reservoir sizes recorded in Table 2.

Table 2: Indicative gas reservoir size assessments for each mining region

	Ash (%)	Relative Density (t/m^3)	Thickness (m)	Measured Gas Content Qm (m^3/t)	Gas Reservoir Size (m^3/m^2)
Region 1	26	1.49	3.9	4.3	24.7
Region 2	30	1.52	4.0	2.6	15.8
Region 3	25	1.48	4.2	4.5	28.2

Ranges for values for each region can be estimated and the level of uncertainty in the GRS calculation quantified[12]. The GRS values show the volume of gas (m^3) per unit area (m^2). For the time frame being considered (e.g. annual forward mine plan assessments), the actual area being considered is multiplied by the GRS to get the volume of gas involved, which can then be summed for each mining region.

Past mining analysis can be used to tie gas make (next section) to GRS.

6.2. GAS MAKE

In answer to Question 14[13] from the Panel, Delta Coal gave the following example of the calculation of fugitive emissions from mining

ROMt x Gas Content (m3/tonne) x [(CH4 content x CH4 conversion) x CH4 GWP] = CH4 emissions

ROMt x Gas Content (m3/tonne) x (CO2 content x CO2 conversion) = CO2 emissions

CH4 emissions + CO2 emissions = Total fugitive emissions from mining

The equation is basically correct <u>if gas make is substituted for gas content</u>.

The gas make curve needs to be defined for each active mining panel. The gas make is assigned from the gas make equation (example Figure 1**Error! Reference source not found.**) for the average weekly production of the area in question.

To account for changes in geology (seam thickness, ash) and gas content in forward assessments, gas make is correlated with GRS.

6.3. MAPPING THE GAS EMISSION FOOTPRINT

Before forecasting gas emissions and looking into methods of emission reduction, it is important to understand and quantify where the gas is coming from and the controls on gas emission from the existing operation. As previously noted, this covers gas from each of the:

- Active mining areas
- Past, "legacy" mining areas
- Stockpile coal prior to dispatch

Each of these areas requires a scheme to be established for direct measurement and/or better utilisation of currently available data (such as real time and tube bundle gas concentration monitoring, and ventilation surveys).

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[12] Probability modelling using an EXCEL add-in

[13] Document *IEAPM Response to Questions Report.pdf*, page 42 dated 23/10/23

7.0 BASELINE EMISSIONS AND GREENHOUSE GAS MANAGEMENT PLAN

Improvement in GHG emissions over time require a baseline against which to measure performance (Safeguard Mechanism). In coal mining, baselines set on assessment of future gas emission inherently have a high level of uncertainty, even with good data sets. For the Project which has limited gas reservoir data, it appears that the only practical option is to set a baseline on past emissions.

Current baselines[14] are 312,302 t CO_2 e for CV and 210,243 t CO_2 e for MC, which together total 522,545 t CO_2 e. This is less than the historical average of 631,612[15] t CO_2 e.

The Air Quality and Greenhouse Gas Management Plan (AQGHGMP)[16] includes coverage of GHG assessment and control. It seeks to address development consent and project approval conditions for CVC and MC. The Greenhouse Gas Management section is covered in six pages with a larger part of the report on air quality covering 11 pages.

The Panel considers that there should be a standalone GHG management plan that more thoroughly covers:

- Mapping the GHG emission footprint
- Assessment of forward GHG emissions
- Design and implementation of GHG emission reduction measures

A case has been made in the body of this IEAPM advice report to provide a detailed measurement scheme for mapping the GHG footprint. Knowing the sources of the emissions in detail is the first step in designing a program to effectively reduce GHG emissions.

On-going gas content testing is required to define the gas content and gas reservoir size in the mining regions covered in the Project.

The AQGHGMP covers control measures at a high level, centring on reducing emissions from previously mined areas. If these constitute 80% of the total GHG emissions, then it would appear to be an area where considerable emission reductions can be made. Mention of these controls should be linked to documents describing in detail the situation, the measurements required, the approach to remedial measures and ultimately, the quantification of the improvements effected.

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[14] https://www.cleanenergyregulator.gov.au/NGER/The-Safeguard-Mechanism/safeguard-data/Safeguard-baselines-table based on historical data

[15] Appendix B, page B2 of Appendix 14 Greenhouse Gas and Energy Assessment Report 21106/R01 July 2022 Umwelt

[16] Document review date 24/01/2022

8.0 SUMMARY CONCLUSIONS AND ADVICE

The GHG assessment by Delta Coal formed part of a broader EIS reported in September 2022. Appendix 14 dated July 2022 was devoted specifically to an assessment of the GHG emissions associated with the Chain Valley Consolidation Project. The Panel's advice is confined to Scope 1 fugitive emissions.

The following covers questions raised by the Department.

1. *Consideration of whether the calculations (including the assumptions used) are reasonable, appropriate, and suitably justified.*

   Total historical emissions are regarded as being well defined from measurement of mine ventilation and gas concentration in the air exiting the mine. Distinguishing between legacy emissions[17] and ROM emissions[18] is important and correctly classified, but the methodology of calculating ROM gas emissions based on a static gas content value is flawed. The break up between legacy and ROM gas emissions is essentially unproven.

   The forecast assumes no change in gas reservoir properties. In particular, gas reservoir size which is the quantity of gas per unit area. Changes in gas content, seam thickness and coal quality will affect this value.

2. *Identification of any areas of deficiency and recommendations to improve or resolve these issues in the assessment.*

   To better assess the ROM emissions, gas concentration and air quantity measurements are required to define the gas make equation which relates gas generated (in m^3/t) to production rate. Linking gas make to gas reservoir size would provide an improved basis for forward assessments. Gas content measurements undertaken to date are relevant and of high quality but more are needed to define the future mining areas. It is not clear whether gas from surface coal stockpiles has been included in the assessment. The Panel recommends direct measurement of gas content of coal leaving the mine portal and leaving the mine site.

3. *Suitability and adequacy of the proposed mitigation and/or management and/or protection measures to avoid, mitigate or minimise the likelihood, extent, and significance of impacts.*

   The Air Quality and Greenhouse Gas Management Plan in its treatment of GHG emission is inadequate and should be a standalone Greenhouse Gas Management Plan (GHGMP). It needs to detail steps and activities to map the GHG emission footprint, assess current and future GHG emissions and detail control measures. The high proportion of "legacy" emissions could provide opportunities for significant[19] emissions reduction. This appears to be recognised by the mine, but requires detail in activities, resourcing and timing. The GHGMP would contain links to documents detailing a range of activities to map, forecast and mitigate the emissions e.g. link to documents on gas content testing of future areas, ventilation surveys to identify zones of high leakage, return gas monitoring of active mining areas for gas make assessments.

4. *Consideration and recommendation of any additional measures to further avoid, minimise and/or mitigate any identified impacts of the project*;

[17] Emissions from non-active mining areas – unrelated to coal production rate
[18] Emissions from active mining areas – directly related to coal production rate
[19] In terms of Scope 1 emissions

Understanding is at an early stage and the first step is to map the GHG emissions. This covers the contributions from ROM emissions, legacy emissions and stockpile coal. Once this has been more clearly defined, areas for emissions reduction can targeted and assessed.

5. *Any recommendations (if required) for additional information to inform the assessment of the Project.*

   In conducting this advice, the Panel has sought and received additional information it has requested to enable preparation of this advice. Future assessments of GHG emissions need to provide detailed insight into methodologies and calculations to facilitate assessments and to better lay a foundation for subsequent assessments by the mining company.

   Further, and not just in relation to this Delta Coal Project:

   The Panel acknowledges that the National Greenhouse Accounts reporting stipulates a fixed "emissions factor" (EF) for the assessment of stockpile gas emission. However, the Panel is of the view that this approach and value, which dates back some 15 years, is now inadequate for properly identifying and managing GHGE and that, going forward, these stockpile emissions should be measured directly.