On behalf of

360 Environmental Pty Ltd

Aigle Royal Group Pty Ltd Lots 11 and 79 Beenyup Road, Banjup Greenhouse Gas Emissions Assessment

February 2021

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1 Summary

This report is a Greenhouse Gas Assessment performed on behalf of Aigle Royal Group Pty Ltd for Lots 11 and 79 Beenyup Road, Banjup to meet the Environmental Protection Authority (EPA) Environmental Factor guidance: Greenhouse Gas Emissions under the Western Australian *Environmental Protection Act 1986*.

The report contains estimates of greenhouse gas emissions from clearing of vegetation at the site within the Development Envelope. The report project boundary includes direct (Scope 1) emissions from vegetation and debris loss, as well as forgone future carbon sequestration (to 2120). The vegetation is assumed to be natural vegetation regrowth after a major clearing event in 1920. Total estimates are based on the Fullcam projections across 200 years, 100 years past and 100 years future.

Emissions also include onsite fuel use for equipment used to clear and prepare the site (Scope 1), as well as indirect (Scope 2) emissions from a demountable office utilising electricity from the grid.

Emissions do not include forecasted annual emissions for the development, although annualised emissions data from mulch and soil carbon breakdown have been calculated.

Estimations of Greenhouse Gases in this report have been prepared in accordance with National Greenhouse Accounts Factors and the Full Carbon Accounting Model (FullCAM, 2020).

2 Facility Description

2.1 The Requirement

Aigle Royal Group Pty Ltd (Aigle Royal) has submitted a section 38 referral under the State of Western Australia *Environmental Protection Act 1986* as Amended for the clearing of up to 8.78 ha of remnant vegetation on Lots 11 and 74 Beenyup Road, Banjup (1350 S38 F01 Proposal).

The EPA (2020) has requested a notice requirement information for assessment in relation to the authroiries Environmental Factor guidance: Greenhouse Gas Emissions which includes :-

- Estimate the expected Scope 1 (direct) and Scope 2 (indirect) net greenhouse gas emissions (i.e. quantity of carbon dioxide equivalent (CO2-e)) on an annual basis and over the life of the proposal inclusive of changes to land use (clearing of vegetation). Detail the methods used to estimate the net greenhouse emissions.

2.2 Project Boundary

The Greenhouse Gas Assessment boundary for this project (Development Envelope) is shown in Figure 1. Scope 1 emissions from clearing of vegetation constitute the primary emissions for the project with minor emissions from fuel combustion in equipment. Scope 2 emissions for electricity used by demountable Site Offices are also considered. Contractors are under operational control while on-site only.

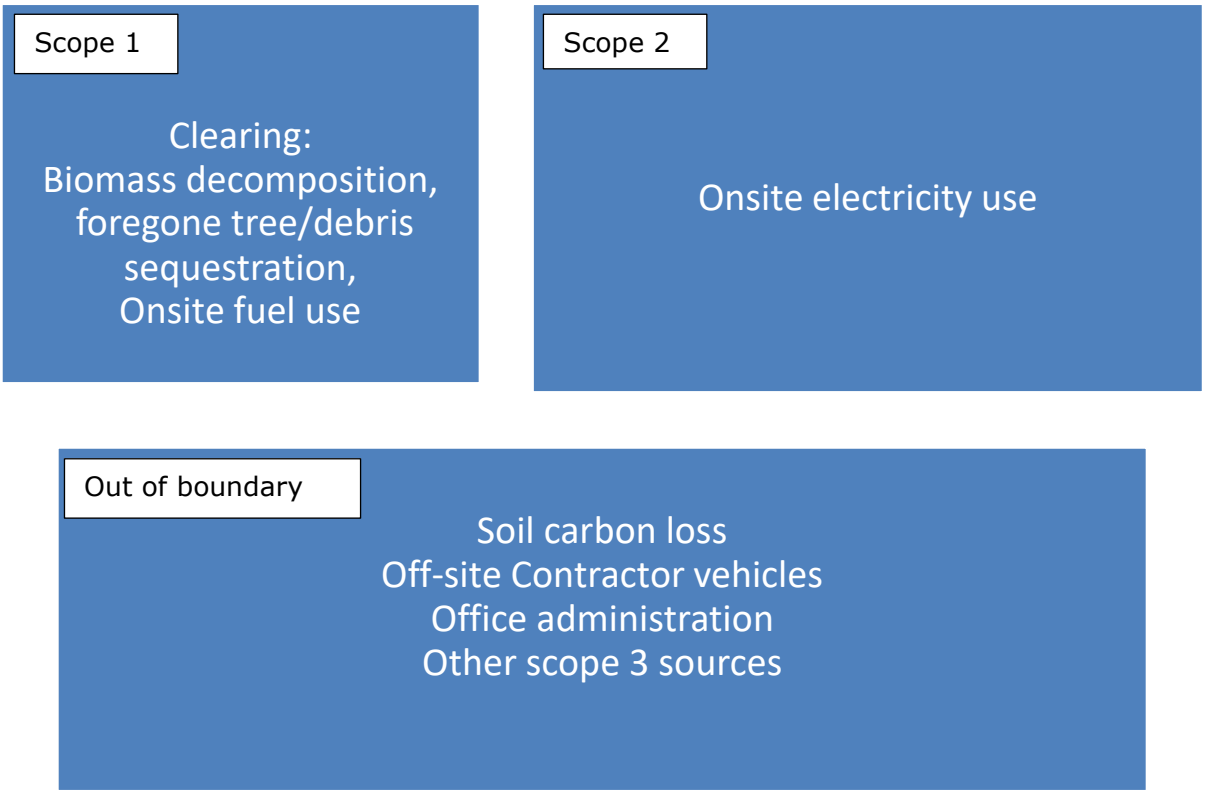

Figure 1 - Greenhouse gas project boundary

2.3 Land Use History

Early land survey maps of the Banjup area (Banjup Residents Group, 2014) show that the project land parcel was part of agricultural land disbursed to private landowners in the late 19th Century (Figure 2). During this period, the colonial Legislative Council legislated that allotment of land and alienation of title required the perspective owner to "improve" the property by clearing native vegetation from it. The *Land Act 1898* (WA) appointed inspectors to determine that owners had "improved" properties in line with these requirements (Charlton and Napper, 2019). It was not until the *Forests Act 1918* that the requirement for clearing was relaxed.

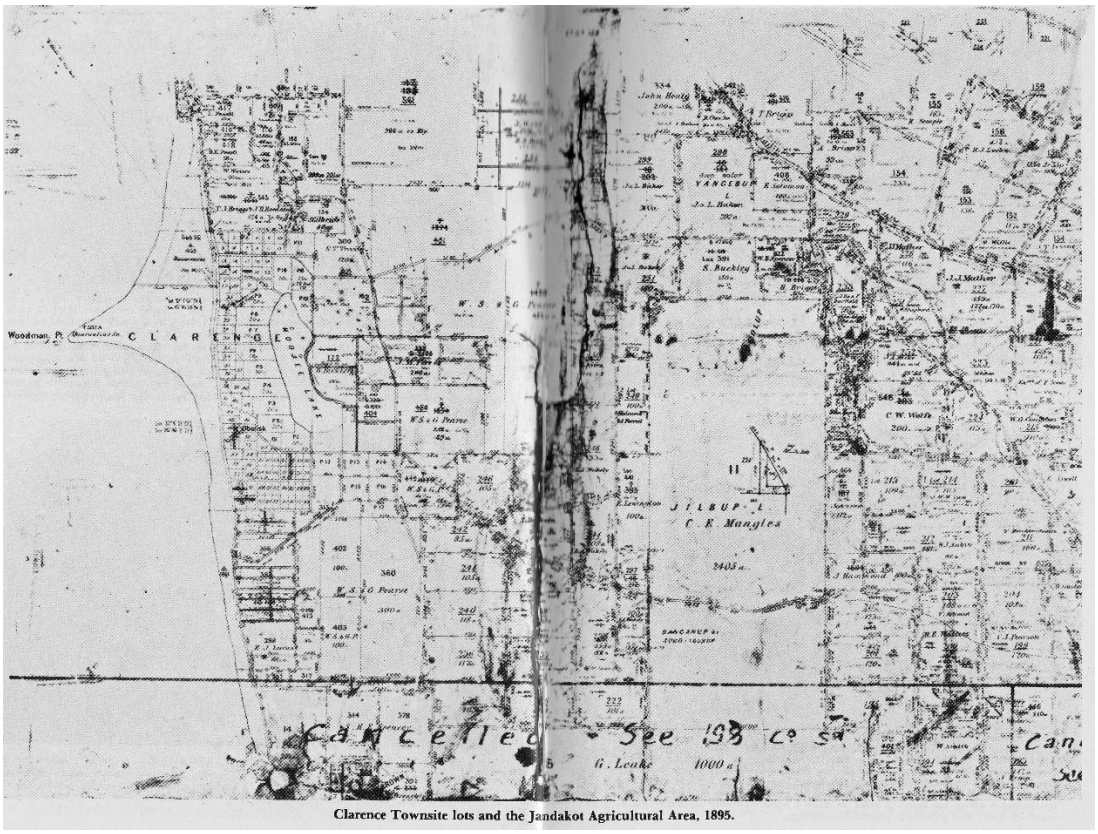

Figure 2 - Survey map of Jandakot Agricultural Area (1985)

Aerial photographs of the area began in 1953 and continued with increasing regularity until present. The are available using the City of Cockburn Intramaps application (http://maps.cockburn.wa.gov.au/Public80/?project=Public). These maps show immature vegetation slowly increasing in density until present with no evidence of significant fire scarring (Figures 3-5).

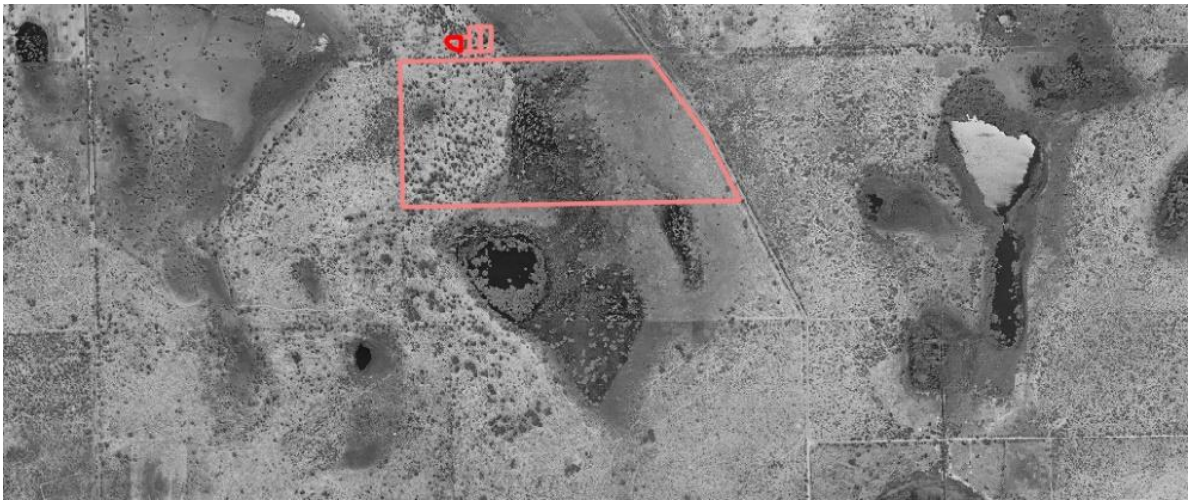

Figure 3 - Aerial Photograph 1953

Figure 4 - Aerial photograph 1981

Figure 5 - Aerial photograph 2020

3 Methodology

3.1.1 Emissions from Land Clearing

Estimation of emissions from land clearing have been undertaken with reference to the Carbon Credits (Carbon Farming Initiative – Avoided Clearing of Native Regrowth) Methodology Determination 2015 as Amended.

This methodology requires a comparison of a baseline and project scenario using the Full Carbon Accounting Model or FullCAM (2020 version). FullCAM is a model developed to estimate Greenhouse Gas emissions and sequestration from land use change for Australia's National Greenhouse Gas Accounts. The model integrates spatial data on land cover change, land use management, climate, plant productivity, and soil carbon over time. Defaults for the FullCAM model are downloaded to match the coordinate position of the property. The coordinates used for this simulation are:

Latitude 32.158823°S and Longitude 115.86950°E.

Simulations for baseline and project scenarios are required to be over a 100-year period modelling period in accordance with the Methodology.

The Carbon Assessment Area is the area to be cleared on the Lot 11 and 79 Beenyup Road, Banjup, Western Australia (1350 S38 F01 Proposal) as determined by field surveys (Figure 6).

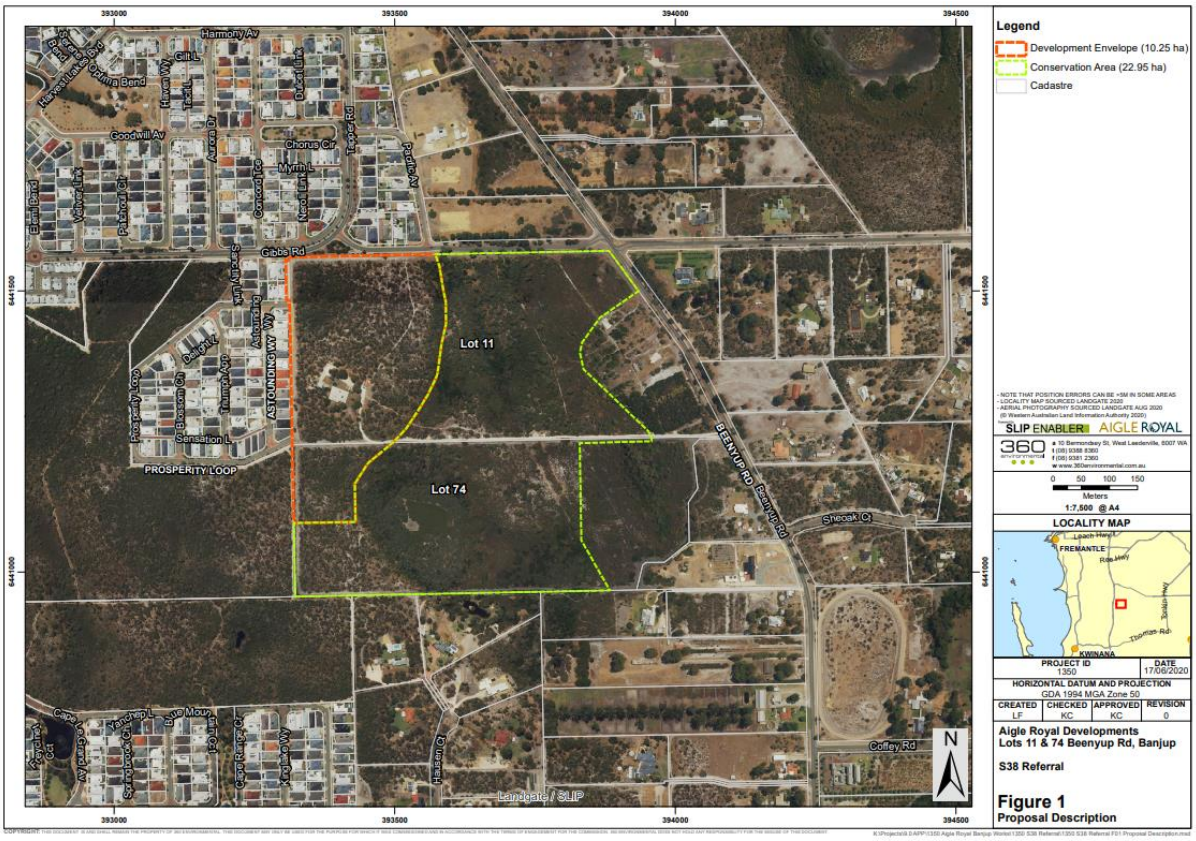

Figure 6 Carbon Assessment Area

Initial conditions for the baseline and project scenarios were set by assuming that the land was cleared in 1920 (100 years prior) and gradually regenerated over a 100-year period without significant bushfire, thinning, or land clearing events. Based on the aerial photographs and likely land use history this is a reasonable assumption, and this assumption will produce a conservative estimate of carbon loss estimates from clearing.

Initial conditions are dependent on FullCAM modelling for the carbon estimation area (CEA) geographic coordinates.

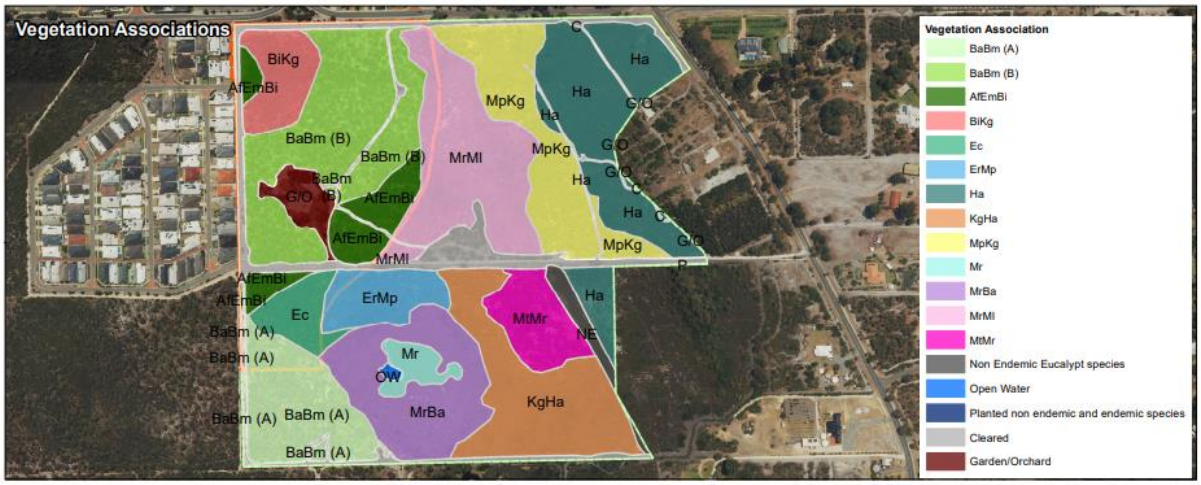

Figure 7 - Native Vegetation Associations on the CEA

A review of the Native Vegetation Association in the area encompassing the CEA show a mix of Banksia, Melaleuca, Eucalyptus and grasslands while the CEA is dominated by low woodland Banksia. The FullCAM defaults for the area may be derived from an average of various vegetation communities, rather than specific to the CEA. Low woodland Banksia have trunk diameters and heights that are smaller relative to other trees in the surrounding area, so bias in the emissions estimation model is likely to be conservative.

The baseline scenario assumes that growth of the natural revegetation of the CEA will continue over the next 100 years, until 2120, without a significant clearing, bushfire, or thinning event. This is a conservative assumption given increasing bushfire hazard risk expected from climate change.

The project scenario assumes that the CEA is cleared with vegetation mulched and soil carbon aerated and disturbed. No cleared vegetation will be disposed of in landfill.

Carbon pools included within the methodology include above ground biomass, below ground biomass, and debris. Emissions associated with soil carbon disturbance are estimated but can be optionally added to the total emissions.

The long-term average baseline carbon stock is the average carbon stock per hectare of the allowed carbon pools over the modelling period of the baseline scenario, multiplied by the area of the CEA.

Equation 1 – Long-term average baseline carbon stock

$$C_{B,i} = \frac{\sum_{k=1}^{1200}(C_{BD,i,k} + C_{BT,i,k}) \times S_i}{1200}$$

Where

CB,i = long-term average baseline carbon stock (in tonnes C) for the ith carbon estimation area.

CBD,i,k = C mass in debris pool (in tonnes C per hectare) for the ith carbon estimation area in the kth month since the modelling start date—from FullCAM.

CBT,i,k = C mass of trees (in tonnes C per hectare) for the ith carbon estimation area in the kth month since the modelling start date—from FullCAM.

Si =the area (in hectares) of the ith carbon estimation area.

The carbon stock for the project scenario is the carbon pool per hectare at the end of the reporting period (year) multiplied by the surface area of the CEA.

The reporting period according to the EPA (2020) environmental factor guideline is on an annual basis.

Equation 2 – Carbon stock for the CEA at the end of each reporting period

$$C_i = \left(C_{D,i} + C_{T,i}\right) \times S_i$$

Where

Ci= C mass of biomass on-site (in tonnes C) for the ith carbon estimation area in the last month of the reporting period.

CD,i = C mass in debris pools (in tonnes C per hectare) for the ith carbon estimation area in the last month of the reporting period—from FullCAM.

CT,i = C mass of trees (in tonnes C per hectare) for the ith carbon estimation area in the last month of the reporting period—from FullCAM.

Si = the area (in hectares) of the ith carbon estimation area.

The annual Scope 1 carbon loss for the CEA is the difference between the carbon stock for the project scenario and the long-term average baseline carbon stock.

Equation 3 - Scope 1 carbon loss from CEA

$$\Delta C_i = C_i - C_{B,i}$$

Where

ΔCi = change in C mass onsite (in tonnes C) at end of first reporting period.

Ci= C mass of biomass on-site (in tonnes C) for the ith carbon estimation area in the last month of the reporting period—from Equation 2.

CB,i =long-term average baseline carbon stock (in tonnes C) for the ith carbon estimation area—from Equation 1.

Equation 4 - Scope 1 CO2-e emissions

$$A = \Delta C_P \times \frac{44}{12}$$

Where

A = project net emissions (in tonnes CO2-e) for the reporting period.

ΔCP = carbon stock change onsite (in tonnes C) in the project area at the end of the reporting period.

3.1.2 Emissions from operation of land clearing and related equipment

The majority of other emissions from land clearing on the site will be from the combustion of diesel in bull dozers performing Excavation and Earthworks, and from Excavators digging utility trenches (if required and subject to final design specification). The project time frame for this project phase will be 4 to 6 weeks with all operations to occur in one event.

Operating hours for equipment were estimated using an online construction estimation calculation (https://permaculturereearthworks.com/calculators/) based on the Caterpillar Performance Handbook.

Bulldozer estimates for hours required for land clearing (grubbing) assume the following.

- Bulldozers used on site will be medium sized dozers such as the Caterpillar D4C series
- Primary soil type is Wet Sand
- Scraping depth is 2 metres
- Blade capacity is 1.68 m^3
- Push speed is 4 km/hr
- Maximum reverse speed is 2 km/hr

Bulldozer estimates for hours required for preliminary Earthworks assume the following.

- Bulldozers used on site will be medium sized dozers such as the Caterpillar D4C series
- Primary soil type is Wet Sand
- Average depth to fill is 2 metres
- Blade capacity is 1.68 m^3

- Push speed is 4 km/hr
- Maximum reverse speed is 2 km/hr

Total Bulldozer operating hours for project earthworks is 144 hours.

Total litres of fuel from bulldozer operation is estimated according to an efficiency of 0.1348 L/kWh derived in Kecojevic, et al. (2011) assuming a Load Factor of 0.5 (NPI Mining Manual). The kW power rating for a Caterpillar D4C Dozer is 60kW. Fuel usage for project Dozer use is therefore 1.16 kL.

Excavator hours for digging utility trenches and back filling assume the following:

- Excavators used on site will be medium sized excavators such as the Caterpillar 311B series
- Cycle time is 12.6 seconds
- Soil type is Sand
- Heaped bucket capacity is 0.0275m^3
- 100m of utility trench per Ha
- Trenches are 1.5m x 1.5m in cross section

Total litres of diesel combusted by excavators is based on an efficiency of 0.21 L/kWh (Hajji and Lewis, 2017). The kW power rating for a Caterpillar 311B excavator is 59kW. Fuel usage for project excavation works is therefore 3.287 kL. This compares closely with the NSW estimate of 3 kL/ month of project time.

The Transport Authorities Greenhouse Group (2013) provides additional factors for other minor emission sources:

2 HiLux diesel utes = 0.65 kL/ month

6" pump running continuously for dewatering = 1.2 kL/month

Scope 1 Greenhouse Gas emissions for use of diesel equipment used for the land clearing project is estimated according to the following equation:

Equation 5 - Emissions of GHG from combustion of Diesel (Stationary)

$$E_{GHG} = Q_D \times J_D \times (F_{CO2} + F_{CH4} + F_{N2O})$$

Where

E_{GHG} = Emissions of greenhouse gases (tCO2-e)

Q_D = Quantity of diesel combusted (1.815 kL)

J_D = Energy content of diesel (38.6 GJ/kL)

F_{CO2} = Emission factor for CO2 from combustion of diesel (69.9 tCO2-e/GJ)

F_{CH4} = Emission factor for methane from combustion of diesel (0.1 tCO2-e/GJ)

F_{N2O} = Emission factor for nitrous oxide from combustion of diesel (0.2 tCO2-e/GJ)

Emissions factors and equations from National Greenhouse Accounts Factors Handbook 2009.

3.1.3 Scope 2 electricity emissions

Electricity use from the grid is associated with emissions offsite (Scope 2) and has been calculated using the method in the National Greenhouse Accounts Factors (2019).

Equation 6 - Emissions of GHG from purchased electricity from the SWIS Grid

$$Y = Q \times \frac{EF}{1\ 000}$$

Y = Scope 2 emissions measured in kg.CO2-e.

Q = the quantity of electricity purchased (kWh).

EF =the scope 2 emission factor for WA 2019 (0.69 kg.CO2-e/kWh)

To estimate the electricity use, operating times and an energy use per area for general commercial offices (Department of Science and Industry,2015) are used.

The operational hours are estimated in accordance with the Environmental Protection Noise Regulations which constrain earth moving activity to be between 0700 to 1900 hours Monday to Saturday. The maximum operating hours will thus be 432 hours, which is used below to conservatively estimate the demountable office's use based on the projected energy use for commercial buildings (Department of Industry and Science Commercial Building Disclosure, 2015) of 385 MJ/m^2/year , and assuming an on-site demountable floor area of 20m^2.

3.1.4 Incidental emissions as a percentage

Small sources with a smaller proportion of total emissions of 1% per instance of a source and 5% in aggregate can be considered as incidental emission sources under NGERS. While specific incidental Scope 1 emissions cannot be easily identified at this stage of the land development, they could include combustion of lubricants, small vehicle traffic, leakage of vehicle and office air conditioner refrigerants, hedgers and trimmers, and the usage of equipment.

4 Results

4.1.1 Scope 1 emissions

Land Clearing – Vegetation decomposition

Emissions associated with vegetation clearing within the Development Envelope constitutes the bulk of the emissions for this project. The Baseline for this project is the scenario where the land was not cleared in 2020 but continued to hold and sequester more carbon for the next 100 years. This baseline can be described as lost or 'forgone' and represents the further maturation of the trees – getting thicker or taller and some further debris associated with a more mature stand.

Emissions of carbon for mulched trees and debris – 79.1 tonnes Carbon/ Ha
Emissions of carbon for lost baseline tree sequestration - 9.6 tonnes Carbon / Ha
Emissions of carbon for lost baseline debris sequestration – 1.5 tonnes Carbon / Ha
Total land cleared – (up to) 8.78 Ha

Total emissions of carbon from land clearing – 962 tonnes Carbon

Total emissions of CO_2 from land clearing (including foregone sequestration until 2121) – **3,525 tCO2-e**

Land clearing – Diesel equipment
As described in the method, these results are based on individual efficiency of various earthmoving plant, factoring in clearing rates per area, energy use and efficiency.

Bulldozers – Clearing / Grubbing = 1.8 tCO2-e
Bulldozers – Earthworks = 3.2 tCO2-e
Excavators – Utility trenching = 8.9 tCO2-e
HiLux Utes – Staff transport = 1.8 tCO2-e
Pumps - Dewatering (if required) = 3.3 tCO2-e

Minor emissions = 0.9 tCO2-e (NGER 5% rule)

Subtotal land clearing diesel equipment = **19.9 tCO2-e**

4.1.2 **Scope 2 emissions**

On site office calculations were made based on maximum permitted earthmoving works which correlate with staff or contractors using the office, commercial office energy use and the emission factor for WA electricity from the grid.

Hours permitted to do site works = 432 hours
Standard container office = 20 m^2
Emission factor = 385 MJ/m^2/year
Site offices = **1.5 tCO2-e**

These emissions constitute a small proportion of the overall project emissions.

4.1.3 **Total Project Emissions and Offset Cost**

Total Project Emissions include Carbon Dioxide equivalents lost due to clearing, including forgone future tree growth and debris build up, direct emissions from fuel use for land clearing activities and Scope 2 emissions from electricity use onsite in the demountable office.

Total Project Emissions- 3,546 tCO2-e

Assuming all emissions are offset at the Current Market Spot Price for ACCUs ($16.10 AUD/tCO2-e) = ~$58,000 AUD.

5 References

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