Government of South Australia

Department of Planning, Transport and Infrastructure

DEVELOPMENT ACT 1993

ORGANICS WASTE TREATMENT AND RECYCLING RESEARCH FACILITY – VARIATION TO THE MAJOR DEVELOPMENT AUTHORISATION

RELEASE OF AMENDMENT TO PUBLIC ENVIRONMENTAL REPORT FOR PUBLIC COMMENT

On 5 December 2003 the Governor of South Australia granted Development Authorisation for the construction and operation of an Organics Waste Treatment and Recycling Research Facility at McEvoy Road / Brooks Road, Buckland Park.

The project was assessed under the major development provisions of Section 46 of the *Development Act 1993*. The level of assessment required the preparation of a Public Environmental Report (PER) to fully investigate the environmental, social and economic aspects of the development.

Notice is hereby given that an application has been made by *Jeffries Garden Soils* to amend the PER pursuant to Section 47 of the *Development Act 1993*. The amendment comprises the construction of a biochar plant (pyrocal continuous carbonisation technology) for the purposes of organics recycling, within the existing composting site.

The works comprise the construction of cooling towers, steam boiler, flue, exhaust gas scrubber, water treatment, combustion heat release, chemical storage and dosing, fuel storage, treated timber management and other associated works. The proponent has prepared an amendment to the PER.

The PER is available for review and public comment at the following locations:

Internet

- www.saplanningcommission.sa.gov.au/scap/publicnotices

Paper Copy

- Department of Planning, Transport and Infrastructure
  Level 5, 50 Flinders Street, Adelaide SA
- City of Playford
  10 Playford Boulevard, Elizabeth, SA

Public Submissions can be made to:
Minister for Planning – c/- Planning and Land Use Services, Department of Planning, Transport and Infrastructure (DPTI), GPO Box 1815 ADELAIDE SA 5000 or via email to scapreps@sa.gov.au.

Should you wish to discuss the application and the public notification procedure please contact Janine Philbey on 7109 7062 or Janine.Philbey@sa.gov.au

The notification period is for 15 business days from 24 July 2019 to 16 August 2019.

Following the close of consultation the proponent may then prepare a formal 'Response Document' addressing issues raised in the submissions received, Council and State Agency referrals, which will also be made available to the public on the SA Planning Portal - www.saplanningportal.sa.gov.au.

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PUBLICATION DATE: 24 July 2019

Jeffries Biochar Project

Buckland Park EMP Appendix F, Biochar Production

1. Introduction

Jeffries has recognised that adding biochar to its compost will enhance the ability of the compost to improve soil health. It intends using a process known as the Organic Rankine Cycle (ORC) to process oversize material from its compost screening activities into biochar. An added benefit of the ORC process is that, being a pyrolytic process, i.e., a low oxygen process, it produces a combustible gas that will be used as a fuel source for electricity production.

The following information has been prepared to provide details of the project.

2. Project Description

Oversize compost consists of the larger fractions remaining after the decomposition and screening phase of composting is completed. It consists mainly of wood fragments and minor amounts of paper, cardboard and plastic that escaped removal during the screening operation.

It is this oversize material that will be the feedstock for the biochar process. Jeffries will be using Australian developed technology known as 'Pyrocal Continuous Carbonisation Technology' (Pyrocal CCT) to produce the biochar. Pyrocal CCT has been implemented commercially since 2014 and, to date, the technology has been deployed in eight other countries.

Biochar produced by the Pyrocal CCT plant will be added to compost products to provide the qualities it is known for, i.e., water holding capacity (3 – 4 times its own weight) and nutrient adsorption.

The plant is designed for an annual throughput of 12,000 tonnes and to operate continuously, i.e., 24 hours /day and seven days/week.

3. Process Description

Complete details of the composting activities undertaken at Jeffries Buckland Park site are set out in the EMP which this appendix will become part of. Hence the process description picks up from the point at which the oversize composted material reaches the biochar plant.

The oversize woody feedstock material is transferred from the onsite sorting plant and unloaded into a storage bay in readiness for the biochar process. Although there should be sufficient residual alkalinity in the feedstock, if alkalinity has to be increased, this will be achieved using hydrated lime and it will be added via a metering screw auger into a port at the rear of each metering feeder that forms part of the carbonisation hearth.

After release from the hopper the oversize material will be fed via conveyor into the carbonisation hearth where it is subject to temperatures of approximately 750^{o}C. The result of this process is biochar and combustible off-gas.

Heat from the burning of the combustion gases is recovered in the 'thermal oxidiser' via a heat exchanger. The recovered heat is used to produce steam which, in turn, is used to produce electricity via the ORC generator.

The burnt combustion gas is recovered and transferred to a condensing wet scrubber to remove harmful impurities before discharge through a 7m high exhaust stack.

Refer to Figure 3.1 for a flow chart showing these steps

4. Environmental Management

Due to the self-contained nature of the Pyrocal CCT plant, the major environmental impact will be gas emissions resulting from the biochar production process. Other impacts that have been considered are:

- Cooling tower management
- Flue gas management
- Noise
- Water treatment
- Wastewater
- Combustion heat release
- Chemical storage and dosing
- Fuel storage
- CCA treated timber management

Cooling Tower Management

The cooling tower is required to cool water from the ORC generator. Cooling is achieved by spraying the hot water through the cooling tower and allowing an updraught of air to cool it. The cooled water is collected at the base of the tower and recirculated to the ORC generator. Make up water is required to replace water lost through evaporation.

Make up water will be chemically dosed to prevent the growth of bacteria, especially legionella and to control corrosion within the tower. The chemical dosing system will be automated and monitored. It will also blow down some water to maintain the set point chemistry.

An appropriately qualified contractor will be employed to carry out routine maintenance and monitoring. This is an essential requirement due to the known risk of legionella bacteria developing within evaporative style cooling towers.

Flue Gas Management

The effective treatment of combustible off-gas is achieved via a thermal oxidiser that is built into the Pyrocal plant. The rotary hearth removes VOCs from the combustible off-gas at a nominal temperature of 600^0C before it enters the thermal oxidiser for a detention period of two seconds at 750 - 920^0C. The exhaust gas then passes through a condensing wet scrubber to reduce particulate, SO_x and NO_x levels to prescribed limits prior to it being discharged to atmosphere via a 7m high exhaust stack. Water from the wet scrubber is recovered and used to quench the biochar.

Any surplus wastewater generated from the plant will be transferred to the compost pad area and used to irrigate compost windrows. Internal windrow temperatures exceed 55^0C thus killing any pathogens that may be present. Jeffries composting processes are certified to AS4454-2012.

A copy of the air quality modelling study undertaken as part of this project is attached, as is technical information provided by the Pyrocal CCT.

Noise Impact
A report on all noise sources, including the proposed biochar plant, at the Jeffries composting facility have been analysed and found to comply with EPA requirements. A copy of the report is attached

Water Treatment

Cooling Tower
As described above, the cooling tower is used to cool water that is heated during its passage through the Organic Rankine Cycle (ORC) generator.

Water passing through the cooling tower must be treated to prevent the build-up of bacteria as well as corrosion within the tower structure.

Treatment is undertaken as follows:

- Reclaimed water from SA Water's Bolivar WWTP is the source water, this is the same water source for composting operations at the site.
- This water will be treated through a two-stage process of Ultrafiltration (UF) followed by chemical treatment to remove cations like calcium, sodium and magnesium, a process known as 'softening'
- Servicing and maintenance of the water treatment plant, which includes the cooling tower and the boiler units, will be managed by a qualified third-party contractor.
- The water treatment plant is expected to produce up to 350 L/day of wastewater containing residual cations.
- Jeffries currently has surplus capacity in its clay-lined evaporation dams to manage this wastewater stream. The nearest dam to the proposed plant has a storage capacity of 1.5 Megalitres

Steam Boiler
Water is also required for the steam boiler which uses heat from the bio char furnace to produce steam for the ORC generator.

Water supplied to the steam boiler must be treated to prevent boiler tube and pipework damage. The two-stage water treatment plant described above will provide the required treatment.

Wastewater Management
Sources of wastewater are:

- Blowdown water
- Exhaust gas scrubber operation
- Water treatment plant reject brine

All blowdown water and exhaust gas scrubber operation will be recovered and used to quench the biochar. Any surplus water will be used to irrigate compost windrows.

The reject brine from water treatment plant will be transferred to existing wastewater evaporation dams within the site.

Stormwater Management

Stormwater that has not been in contact with feedstock will be diverted to land surrounding the biochar plant that is not supporting any site activities, i.e., passive areas of the site.

Stormwater that has been in contact with feedstock, i.e., the feedstock storage area, will be recovered and diverted to the on-site, lined, wastewater evaporation ponds.

Combustion Heat Release

Schedule 22 of the Development Regulations 2008 -2013 includes fuel burning as an activity of major environmental significance if the rate of heat release exceeds 5 megawatts. Heat release from the thermal oxidiser is in the range 0.1 – 1 megawatt, which is well below the level that would trigger its classification as an activity of major environmental significance.

Chemical Storage and Dosing

Water treatment chemicals will be stored on site within a fully enclosed building complete with a concrete floor and internal bunding. Storage volume within the bund will be a minimum of 1.25 times the maximum volume of chemicals stored within the building. A washdown shower will be installed adjacent to the building's access door.

Fuel Storage

The biochar plant will occasionally require diesel fuel during start up. A fully bunded 1kL storage tank will be installed to meet this need.

Management of CCA Treated Timber

Jeffries does not accept CCA treated timber, so the only CCA treated timber that would be present in feedstock received at the site would be that which has either been accidently, or deliberately, mixed with feedstock.

Jeffries is aware of this risk and has adopted the following practices to deal with it:

- The material utilised in the process is originally sourced from kerbside green waste collections. This reduces the likelihood of any large quantities of potentially CCA treated materials compared with commercial sources
- Jeffries employees are trained to inspect all material as it is unloaded and as it is processed to identify and remove contaminants, including CCA treated timber.
- Currently the overall contamination levels in incoming feedstock run at about 1% by weight, the majority of which are stones, metals, glass and plastics.
- Even if the CCA is not removed during the process it is estimated to be a negligible portion of the current 1% of the overall contamination that is within the organic feedstock.

5. **Mixing of Biochar and Compost**
   Finished product from the proposed plant (Biochar) will be moved out of the shed and mixed with compost and other blended products using existing plant and equipment such as front-end loaders, Top Turner or trommel screens

Attachments:

- Air quality modelling report
- Noise assessment report
- gTET (Green Thermal Energy Technologies) Potential Emissions Report
- Emissions Profile for a Pyrocal Dual CCT Carbonisation System
- Pyrocal flow chart

Attachment 1

Air Quality Modelling Report

ENVIROSCAN
INDUSTRIAL & MARINE SURVEYS

Biochar Energy Generation
Emissions Assessment

Report 18 - 1032

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Biochar Energy Generation
Emissions Assessment

Report 18 - 1032

Prepared for:	Jeffries Group 412 Hanson Road North Wingfield South Australia 5013

By:	Enviroscan Industrial & Marine Surveys PO Box 75 Brighton SA 5048 Phone: 0408 831 088 info@enviroscan.com.au

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Status	Report	Date	Prepared	Reviewed	Authorised
Draft	18-1032	17/10/18	BM	RF	BS
V1	18-1032	28/11/18	BM	RF	BS

1. Introduction

The Buckland Park composting facility (Figure 1) has been operated by the Jeffries Group for many years. A number of innovations have been introduced in recent years and the current proposal is to install a Biomass Power Station. This involves pyrolysis of biomass to produce biochar (activated carbon) for use as a soil amendment.
Several benefits of biochar soil treatment are evident, including carbon sequestering, reduced CO_2 emissions, enhanced agricultural productivity and rehabilitation of degraded soils.

The Power Station will include a 355 kWe ORC generator with cooling tower and ancillaries. A Pyrocal Continuous Carbonisation System will thermally upgrade a wide range of biomass to biocarbon and combustible off-gas which is immediately oxidised to a clean exhaust gas. The rotary hearth removes the VOCs at a nominal 600^0C/100s before entering the thermal oxidiser (nominal 2 seconds at above 750^0C) followed by a third generation condensing wet scrubber to ensure compliance with EPA emission limits.

BIOCHAR systems have been evaluated for licensing in several jurisdictions including New South Wales in Australia.

Enviroscan was commissioned to assess the Pyrocal emissions, based on data supplied by the client and manufacturer, for compliance with EPA Air Quality criteria (2016 Air Quality Policy, Schedule 2). This was carried out using CALPUFF dispersion modelling and TAPM meteorology.

The emissions assessment was co-ordinated by Rob Rodenburg (Rodenburg Waste Solutions), with input from Jeffries Group personnel (Renga Ramasamy) and PYROCAL (Dr James Joyce).

EPA reviewed the draft report and requested additional details on the BIOCHAR emissions including odour, metals, PAHs and dioxins. Justification for the adopted ambient background levels of $PM_{2.5}$ and PM_{10} was also specified. These issues are addressed in the following sections.

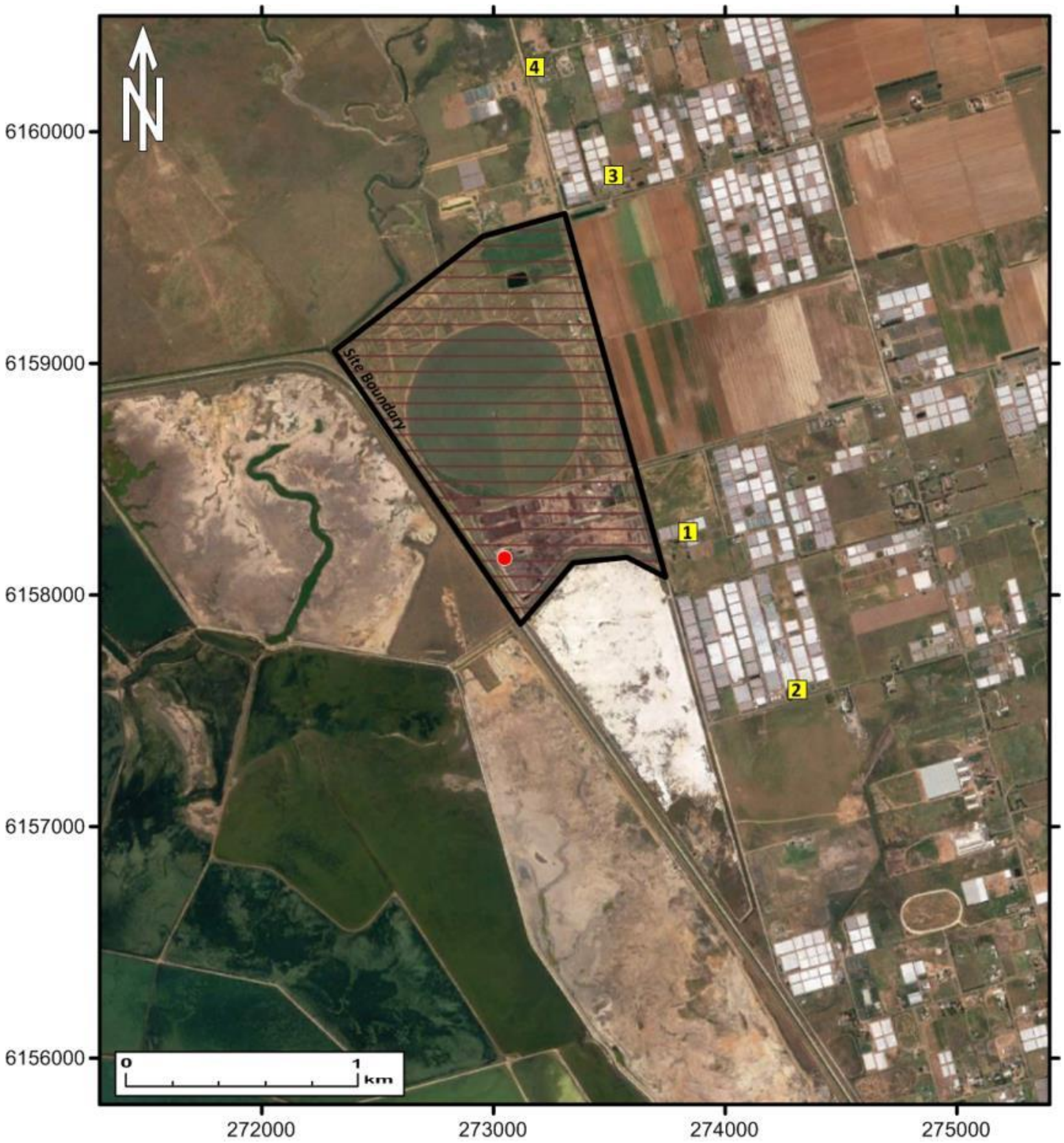


Figure 1 Jeffries composting site with Biochar plant (red).

The Biochar plant is located near the western boundary of the Jeffries composting site (Figure 1). Commercial market gardening is carried out east of site with scattered residences (nearest residences indicated, 1 to 4). Salt evaporation pans extend over large areas west of the composting site.

The Biochar plant will operate on a 24/7 basis, with an annual throughput of nearly 12,000 tonnes. The process flow sheet is shown in Figure 2.

The exhaust flue is 0.25 m diameter with exit 7 m above ground level. The exhaust gas stream is hot at 90^0C and with an exit velocity of 30 m/s and flow rate of 2 Nm^3/s.

Emissions specified by the manufacturer (PYROCAL) are listed in Table 1.

Pollutant	ng/Nm^3	mg/Nm^3	g/s
$PM_{2.5}$		30	0.060
PM_{10}		50	0.10
Total Particulate Matter		100	0.20
Nitrogen oxides		82	0.17
Carbon monoxide		250	0.50
Sulphur dioxide		43	0.086
Benzo(a)pyrene PAH**		<0.0056	0.000011
Dioxins and Furans (WHO 0S TEQ)*	<0.05		0.1 ng/s
Hydrogen sulphide*		0.021	0.000042
Cadmium*		0.0086	0.000017
Lead*		0.014	0.000028
Arsenic*		0.024	0.000048
Mercury*		0.0081	0.000016
Antimony*		<0.006	0.000012

*data extract released from confidential NATA report Ektimo R003770
**assumes worst-case with zero recovery in quenched biochar (EAL Report H5405)

Table 1 Biochar plant specified emissions.

Odour emission has not been detected by Dr James Joyce (PYROCAL principal engineer) during normal biochar operation. The biochar process is not conducted under reducing conditions (char discharge only) and there is little scope to produce hydrogen sulphide. Hydrogen sulphide is sufficiently soluble that the wet scrubber would absorb it prior to the submerged biochar quench.
The Jeffries BIOCHAR plant design (Figure 2) captures any off-gassing from the char which is then drawn back into the hearth and passed through the oxidiser. The trial data in Table 1 (above) with 0.021 mg/Nm^3 hydrogen sulphide emission did not include this design feature.

Four nearest residences were selected as Sensitive Receptors as shown in Figure 1.

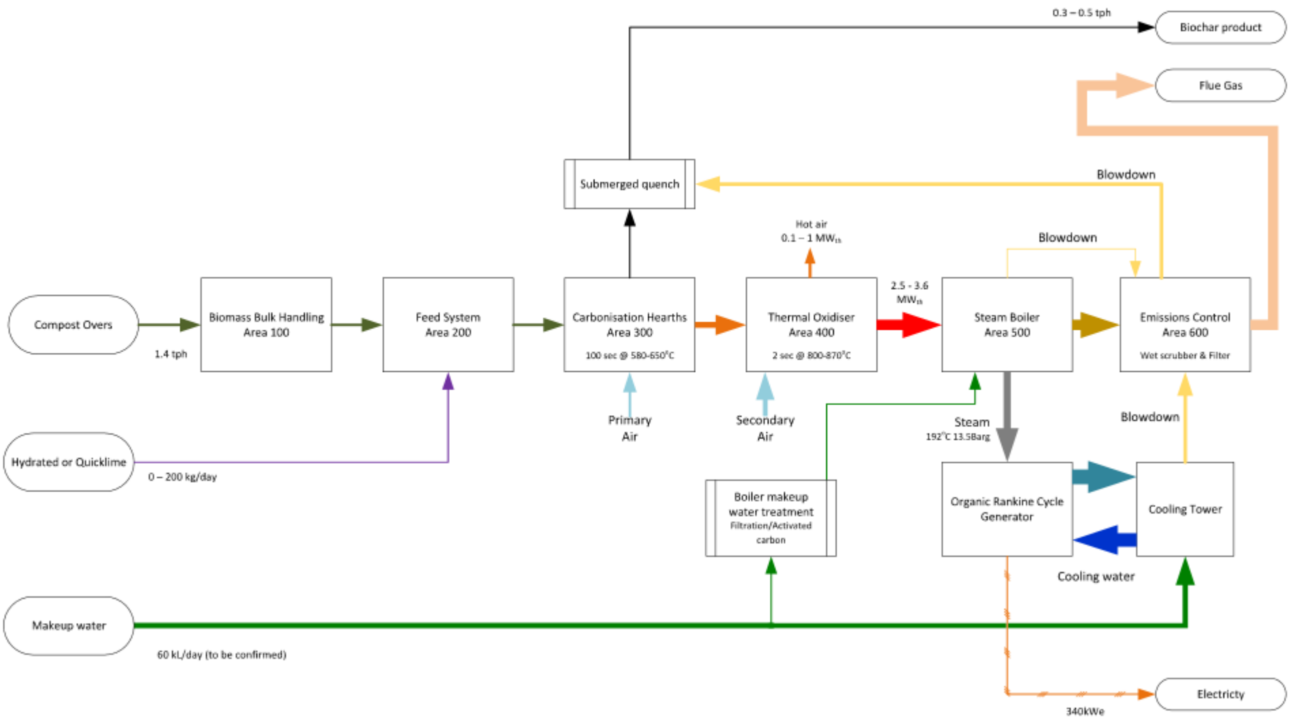


Figure 2 Flow Diagram of Jeffries Biochar plant.

2. Dispersion Modelling

Dispersion modelling was performed with CALPUFF version 7.2 (Scire et al 2000) in accord with the EPA “Ambient air quality assessment” 2016 guideline.
CALPUFF was selected for this Air Quality Impact Assessment as it is a multi-layer non-steady-state puff dispersion model able to simulate effects of time- and space- variable meteorology on pollutant transport. CALPUFF can accommodate low wind-speed dispersion, coastal fumigation and photochemistry.

TAPM was used to generate Y2009 met data for CALPUFF via CALMET. Y2009 is considered a typical meteorological year by the EPA, which has been requested for all dispersion modelling for several years now and, as such, provides consistency between projects.

The TAPM V4 model was described by Hurley et al. in CSIRO Research Paper No. 25, 2008. Excerpts are included here.

The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for three-dimensional simulations. The model solves the momentum equations for horizontal wind components, the incompressible continuity equation for vertical velocity, and scalar equations for potential virtual temperature and specific humidity of water vapour, cloud water/ice, rain water and snow. The Exner pressure function is split into hydrostatic and non-hydrostatic components, and a Poisson equation is solved for the non-hydrostatic component. Explicit cloud microphysical processes are included.

The turbulence terms in these equations have been determined by solving equations for turbulence, kinetic energy and eddy dissipation rate, and then using these values to represent vertical fluxes by a gradient diffusion approach, including counter-gradient terms. A vegetative canopy, soil scheme, and urban scheme are used at the surface, while radiative fluxes, both at the surface and at upper levels, are also included.

The TAPM model used here consists of a series of 5 grids, each 1681 points with 30 vertical levels. The outer grid (400km square) with 10 km spacing is used to calculate the wide scale meteorology. The five grids are nested with each inner grid providing about 2 times more resolution. The innermost grid spacing of 400 metres defines the area for local scale meteorology. Within this grid is a slightly smaller CALMET grid (14 x 14km at 400m spacing).

Meteorological data is extracted from the CSIRO synoptic database into the outer grid. Meteorology for the points in between those for which data is available from the database is then calculated. These calculations take into account insolation, reflection or absorbtion of solar energy at ground level due to type of ground cover, temperature, soil moisture and terrain. The process is repeated for each hour of the year. Meteorological information from this grid is then transferred to the next grid and the infill calculated as for the outer grid. This is repeated until meteorological data is complete for all five grids.

The TAPM meteorology is saved for use in CALMET including microscale meteorology, which then provides the meteorology input for CALPUFF.
A Y2009 wind rose was constructed for the Buckland Park site (Figure 3). Mixing height diurnal variation was plotted (Figure 4) for average, min/Max, 10%ile and 90%ile heights. Dominant winds are from the south-west.

A CALPUFF pollution grid was set up (4 x 4 km) with 100m spacing within the CALMET inner grid.

Model configuration is summarised in Table 2, below.

Grid centre coordinates	$34^0 41.5'$ S, $138^0 31.5'$ E
Year modelled	1 January to 31 December 2009
TAPM grid domains	.Five nested grids with 41 x 41 horizontal grid points, spacing of 10, 4, 2, 1 and 0.4 km
Vertical grid levels	30 vertical levels up to 8 km above sea level
CALMET grid domain	36 x 36 horizontal grid points, 0.4 km spacing
CALMET run type	No surface, overwater or upper air observations. Initial 3D wind fields from TAPM.
Terrain	Geoscience Australia 9 arc second data
Radius of terrain influence	6 km
CALPUFF grid domain	41 x 41 horizontal grid points, 0.1 km spacing

Table 2 CALPUFF model configuration.

Particulate emissions were modelled as a conserved species, without deposition effects. Geometric mean diameters applied were 2.5 µm ($PM_{2.5}$), 10 µm (PM_{10}) with nil standard deviation.

Nitrogen oxides were modelled as 100% Nitrogen dioxide (NO_2).

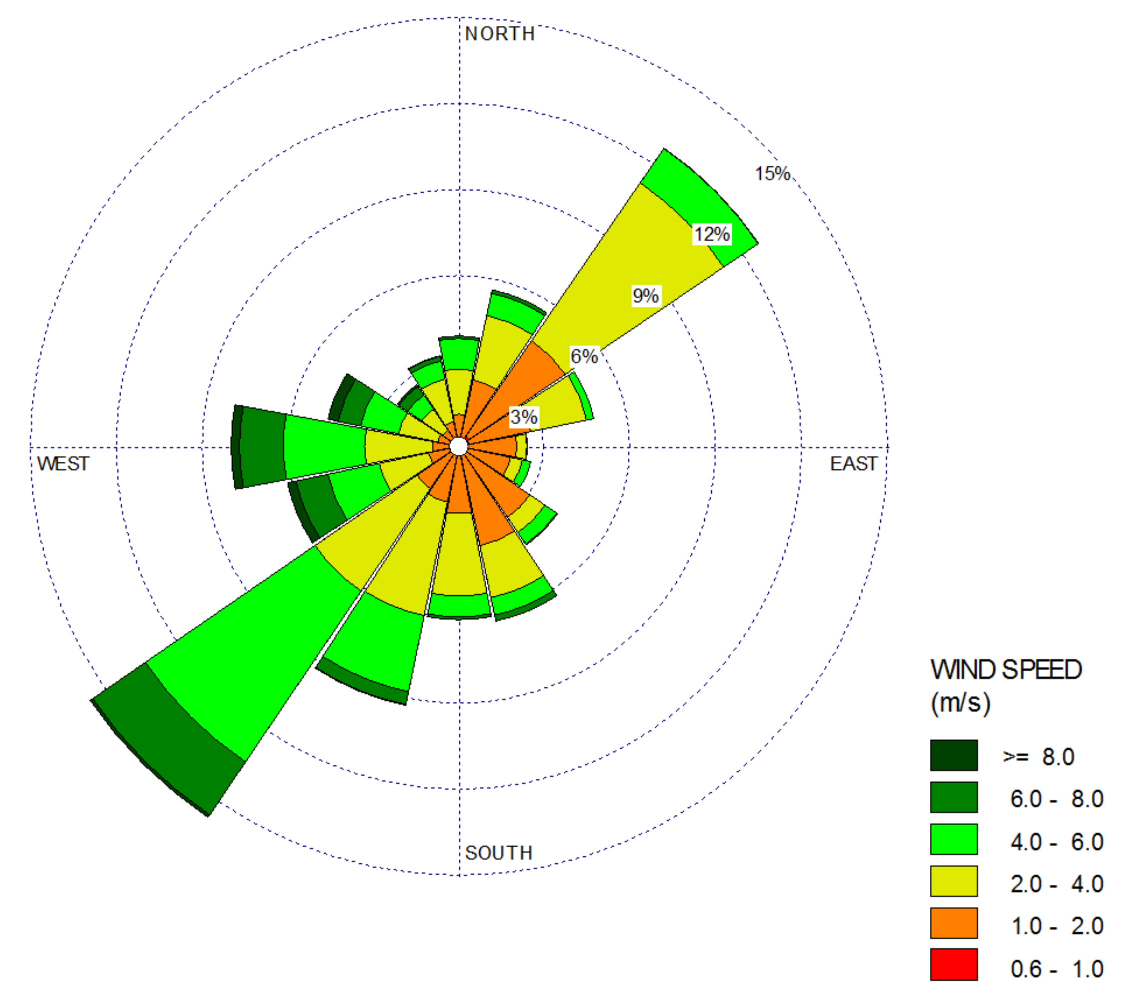
Ambient background values were included in the dispersion model as listed in Table 3 below.

Hourly data for $PM_{2.5}$, PM_{10}, SO_2 and NO_2 was sourced from the Le Fevre 2 air quality monitoring station (Y2016).
Particle data from the Elizabeth EPA monitoring station was also assessed (Y2016) for $PM_{2.5}$ (24 hours 5.8 µg/m^3, 12-months average 4.7 µg/m^3) but the datasets were incomplete and included some negative numbers.
The Le Fevre 2 particulate dataset was adopted as a conservative approach.
A recent emissions assessment for the emergency power station on the Holden site, Elizabeth (VIPAC, 2017 Temporary Generator Air Quality Assessment Doc. 70Q-17-87-TRP-630580-2) also adopted Le Fevre 2 Y2016 data for background values of fine particles.

Carbon Monoxide background concentrations were sourced from the Adelaide CBD SA EPA monitoring station.

Pollutant	Averaging period	Background (µg/m^3)	Reference
$PM_{2.5}$	24 h	7.4	Le Fevre 2, 2016, 70th %ile 24 h average
	12 m	6.5	Le Fevre 2, 2016 Average
PM_{10}	24 h	22	Le Fevre 2, 2016, 70th %ile 24 h average
Nitrogen dioxide	1 h	14	Le Fevre 2, 2016, 70th %ile
	12 m	11	Le Fevre 2, 2016, Average
Sulphur dioxide	1 h	5.7	Le Fevre 2, 2016, 70th %ile
	24 h	5.7	Le Fevre 2, 2016, 70th %ile 24 h average
	12 m	5.5	Le Fevre 2, 2016, Average
Carbon monoxide	1 h	2800	CBD hourly CO, 2016, 100th %ile
	8 h	2600	CBD 8 hr average CO, 2016, 100th %ile

Table 3 Adopted Background concentrations.



Total meteorology data: 8760 hours	Average wind speed: 3.1 m/s	Calm frequency (0.5 m/s): 1.9 %

Figure 3 Buckland Park wind rose Y2009.

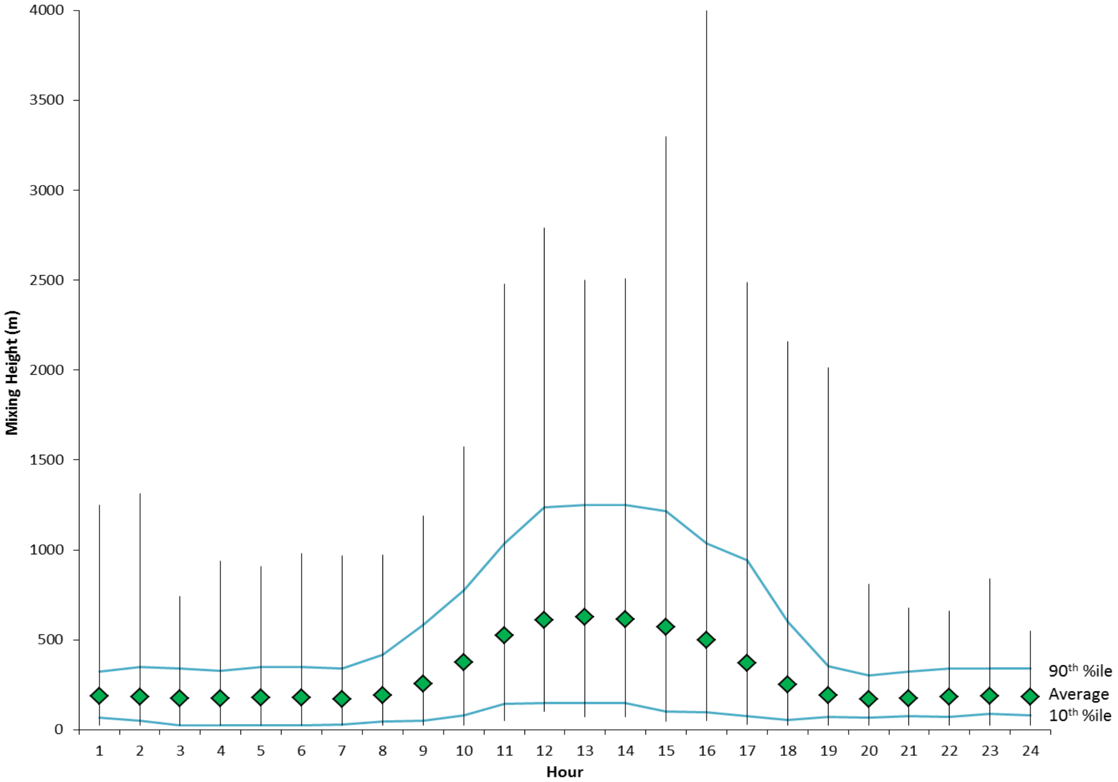


Figure 4 Distribution of mixing heights.

3. Modelling Results

The CALPUFF predicted ground level concentrations are summarised in Table 4 with no exceedances of the Air Quality Policy Schedule 2 criteria.

Pollutant	Averaging period	Background (µg/m^3)	Maximum glc (µg/m^3)	% of criteria	AQ Policy glc criteria Schedule 2 (µg/m^3)	Complies with 2016 Air Quality Policy
$PM_{2.5}$	24 hour 12 month	7.4 6.5	16 7.4	64 93	25 8	✓ ✓
PM_{10}	24 hour	22	36	72	50	✓
Nitrogen dioxide	1 hour 12 month	14 11	71 14	28 23	250 60	✓ ✓
Sulphur dioxide	1 hour 24 hour 12 month	5.7 5.7 5.5	35 18 6.8	6 8 11	570 230 60	✓ ✓ ✓
Carbon monoxide	1 hour 8 hour	2800 2600	3000 2700	10 24	31,240 11,250	✓ ✓
Dioxins	1 hour	0	0.000034 ng/m^3	< 1	0.1 ng/m^3 European guideline	✓
Benzo(a) pyrene	3 minutes 12 months	0	0.0055 0.18 ng/m^3	< 1 60	0.8 0.3 ng/m^3	✓ ✓
Hydrogen sulphide	3 minutes	0	0.021	14	0.15 odour	✓
Cadmium	3 minutes	0	0.0084	23	0.036	✓
Lead	12 months	0	0.00044	< 1	0.5	✓
Arsenic	3 minutes	0	0.024	13	0.19	✓
Mercury	3 minutes	0	0.0079	< 1	4 bioaccumulation	✓
Antimony	3 minutes	0	0.0059	< 1	19	✓

Table 4 Maximum glc including background.

The maximum ground level concentration (glc) inclusive of background is listed for each pollutant. The maximum glc is compared to the EPA AQ Policy Schedule 2 criteria and expressed as a percentage.
The highest % is recorded for $PM_{2.5}$ where the maximum glc of 7.4 (12-month averaging time) represents 93% of the Schedule 2. The adopted background value of 6.5 µg/m^3 contributes 88% of the $PM_{2.5}$.

Five of the modelled pollutants remain below 1% of the Schedule 2 criteria, including: dioxins, benzo(a)pyrene, lead, mercury and antimony.

Table 5 lists predicted glcs for the four sensitive receptors (residences) shown on the glc plots, with no exceedances of Schedule 2 criteria.

Pollutant	Averaging period	Back-ground (µg/m^3)	Maximum glc at sensitive receptor (µg/m^3)				AQ Policy glc criteria (µg/m^3)	Comply
			1	2	3	4		
$PM_{2.5}$	24 hour	7.4	8.0	7.7	7.6	7.5	25	✓
	12 month	6.5	6.5	6.5	6.5	6.5	8	✓
PM_{10}	24 hour	22	23	23	22	22	50	✓
Nitrogen dioxide	1 hour	14	20	18	18	16	250	✓
	12 month	11	11	11	11	11	60	✓
Sulphur dioxide	1 hour	5.7	8.6	7.7	7.5	6.9	570	✓
	24 hour	5.7	6.6	6.2	6.0	5.9	230	✓
	12 month	5.5	5.5	5.5	5.5	5.5	60	✓
Carbon monoxide	1 hour	2800	2820	2810	2810	2800	31,240	✓
	8 hour	2600	2610	2600	2600	2600	11,250	✓
Hydrogen sulphide	3 minutes	0	0.0017	0.0011	0.0011	0.00070	0.15 odour	✓

Table 5 Maximum glc at sensitive receptors.

Surfer version 15 was used to plot ground level concentrations of selected pollutants on a 2017 Google Earth photomap, including $PM_{2.5}$, Nitrogen dioxide, Sulphur dioxide, Hydrogen sulphide, Cadmium and Arsenic.
This series of glc plots are shown below (Figures 5 through 10) with descriptive captions.
The six glc plots are similar in that they show the biochar plant emissions are largely confined to the Jeffries compositing site.
The displayed glc contour ranges from about half the Schedule 2 criteria for $PM_{2.5}$ to ~1/10th for NOx, SO_2, Hydrogen sulphide, Cadmium and Arsenic.

Hydrogen sulphide is a proxy for odour and Figure 8 indicates that in the very unlikely event of an emission from the proposed plant, ground level concentrations would remain well below the Schedule 2 odour criterion of 0.15 µg/m^3 (0.00015 mg/m^3).

These dispersion modelling predictions indicate that the operation of the Biochar plant will not adversely impact the amenity of scattered local residential receptors and commercial market gardening activities.

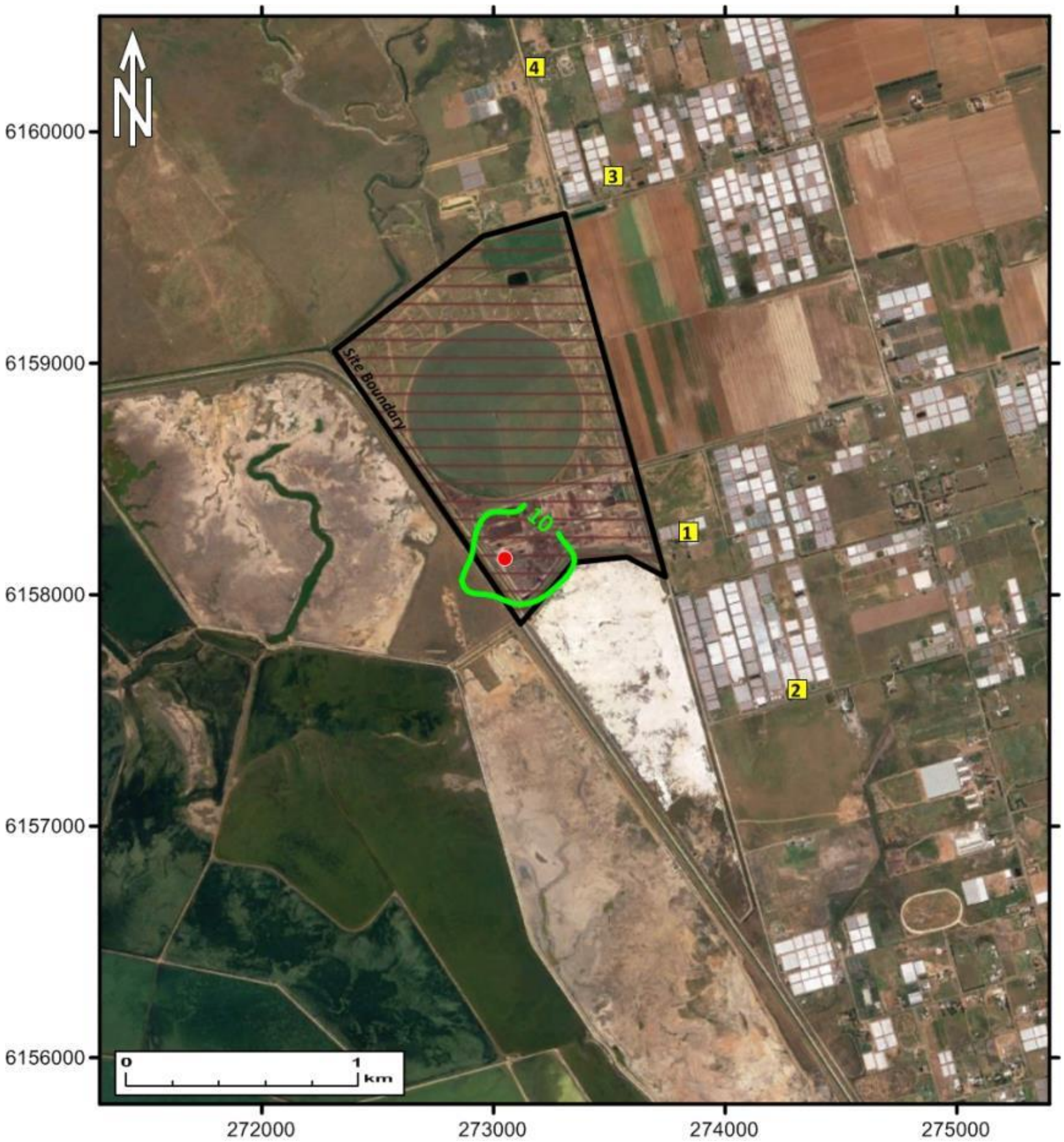


Figure 5 PM2.5 (24 hour) glc map.

Contoured at 10 µg/m^3
Complies with Schedule 2 glc of 25 µg/m^3

Figure 5 shows $PM_{2.5}$ 24 hour averaging period glc contoured at 10 µg/m^3. This is less than half the Schedule 2 criterion of 25 µg/m^3 and remains almost entirely confined to the Jeffries site.

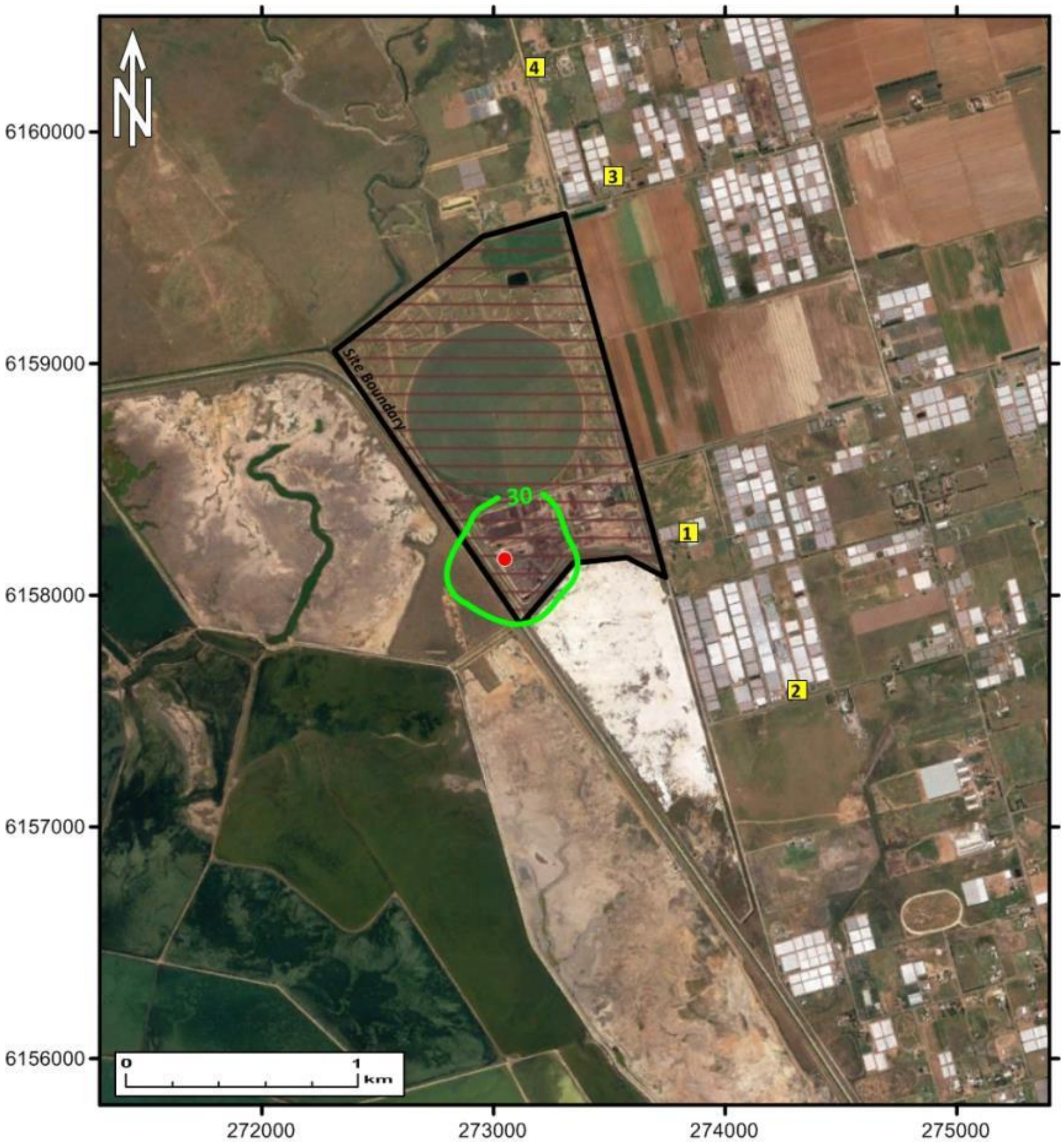


Figure 6 Nitrogen dioxide (1 hour) glc map.

Contoured at 30 µg/m^3
Complies with Schedule 2 glc of 250 µg/m^3

Figure 6 shows Nitrogen dioxide (1 hour) averaging period glc contoured at 30 µg/m^3. This is about 12% of the Schedule 2 criterion of 250 µg/m^3 and is largely confined to the Jeffries site.

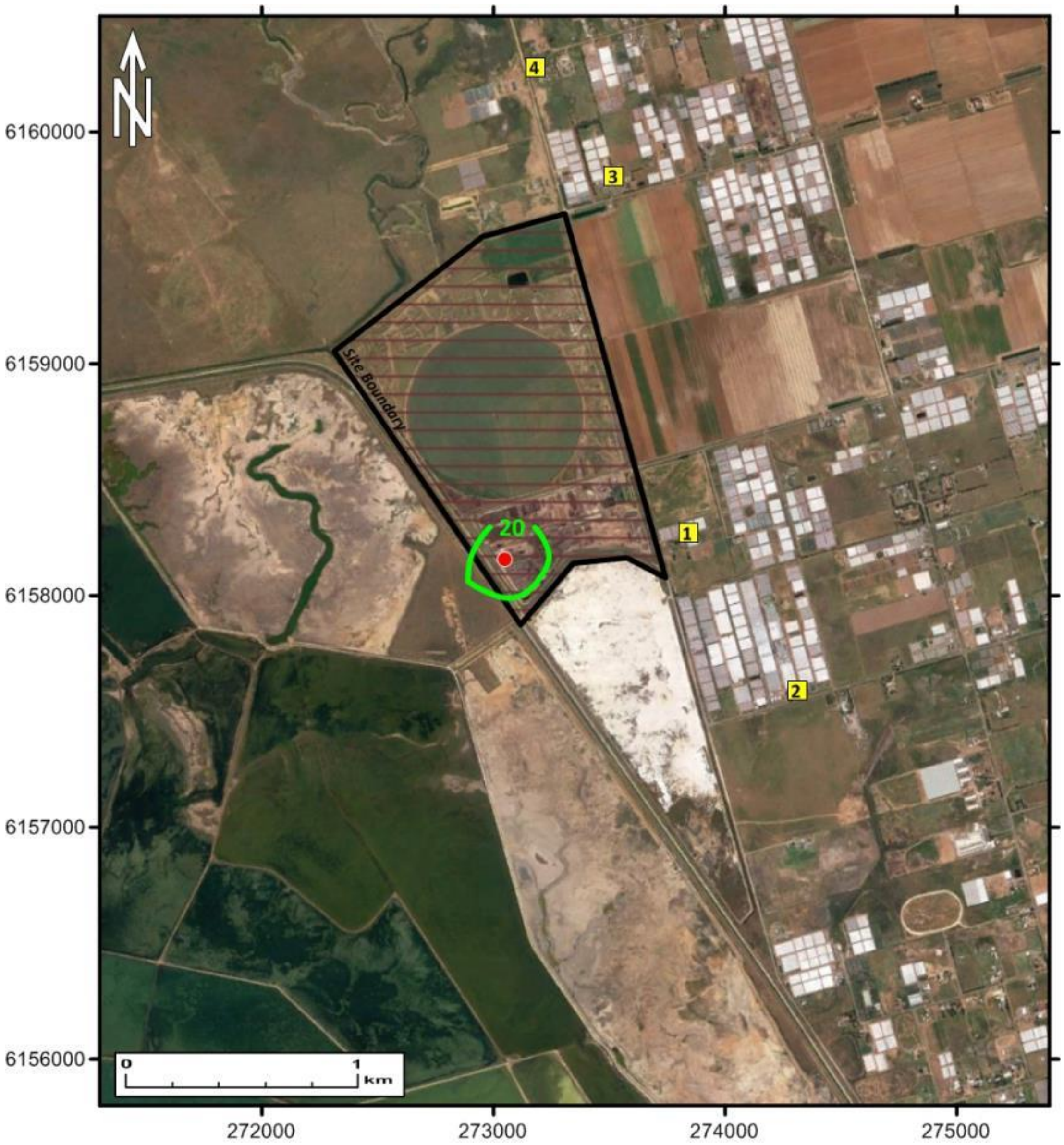


Figure 7 Sulphur dioxide (1 hour) glc map.

Contoured at 20 µg/m^3
Complies with Schedule 2 glc of 570 µg/m^3

Figure 7 shows Sulphur dioxide (1 hour) averaging period glc contoured at 20 µg/m^3. This is less than 5% of the Schedule 2 criterion of 570 µg/m^3 and is practically confined to the Jeffries site.

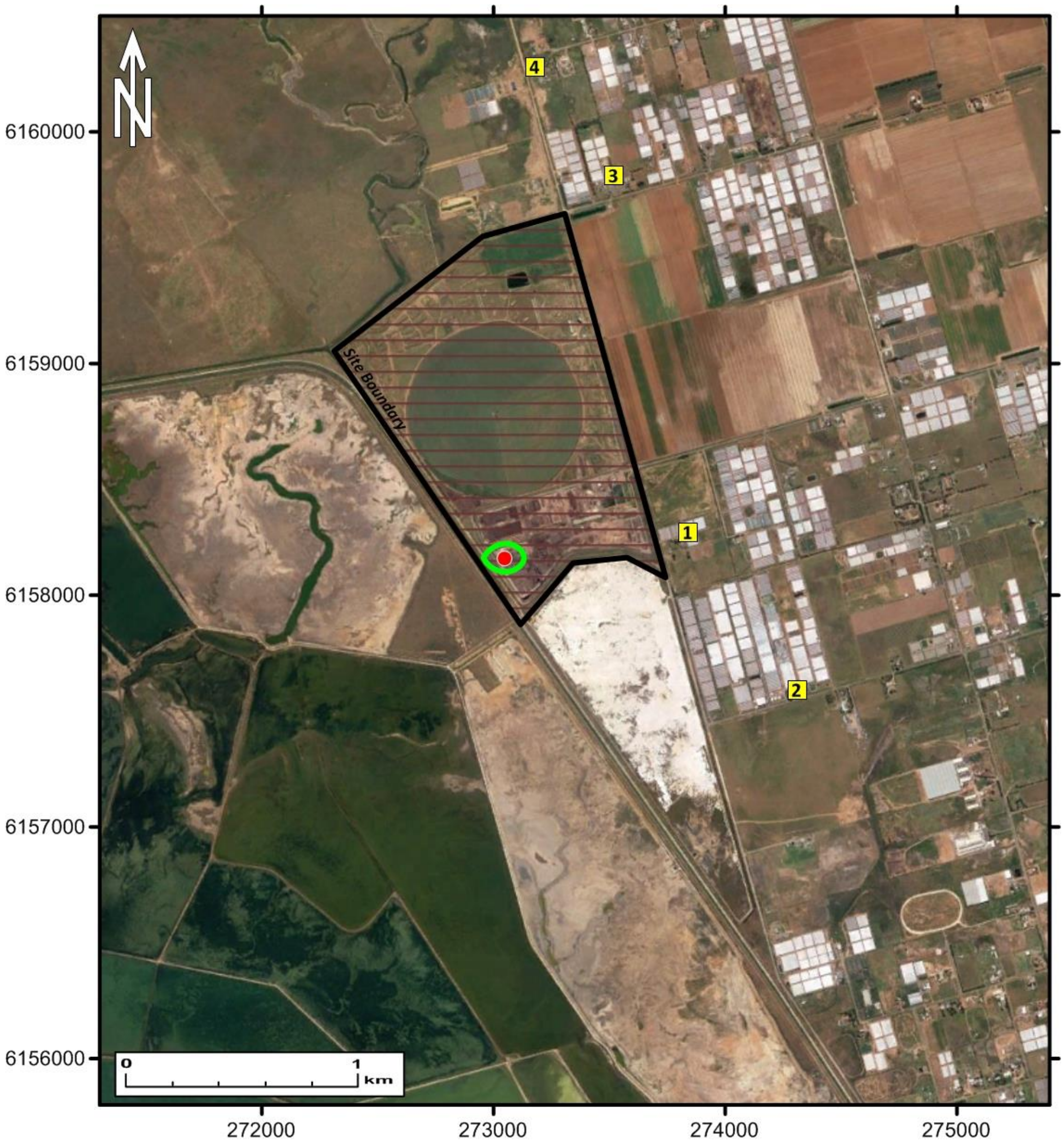


Figure 8 Hydrogen Sulphide (3 minute) glc map.

Contoured at 0.015 µg/m^3
Complies with Schedule 2 glc of 0.15 µg/m^3

Figure 8 shows Hydrogen sulphide (3-minute) averaging period glc contoured at 0.015 µg/m^3. This represents 10% of the Schedule 2 criterion of 0.15 µg/m^3, and is confined to the Jeffries site.

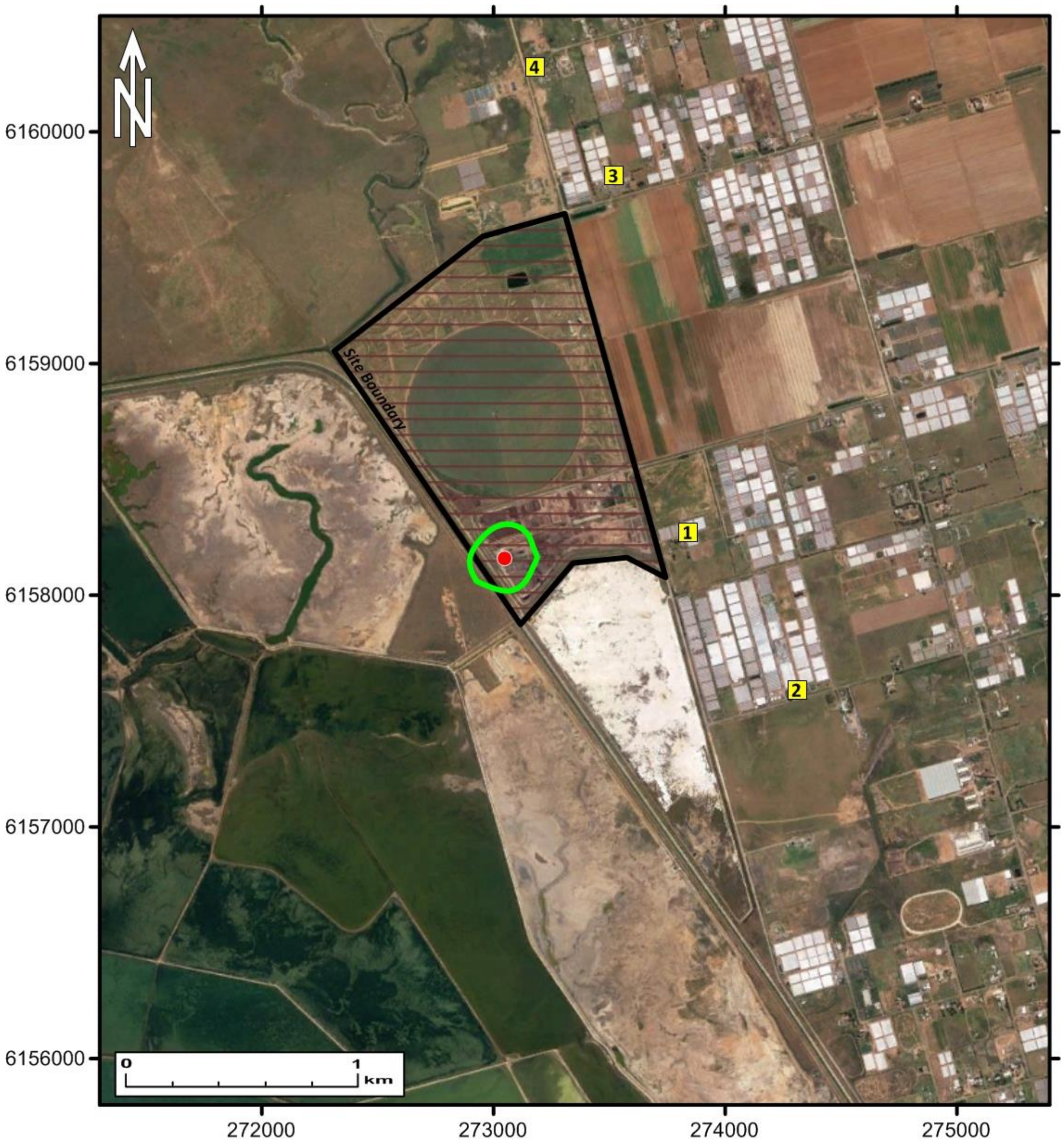


Figure 9 Cadmium (3 minute) glc map.

Contoured at 0.0036 µg/m^3
Complies with Schedule 2 glc of 0.036 µg/m^3

Figure 9 shows Cadmium (3-minute) averaging period glc contoured at 0.0036 µg/m^3. This represents 10% of the Schedule 2 criterion of 0.036 µg/m^3 and is essentially confined to the Jeffries site.

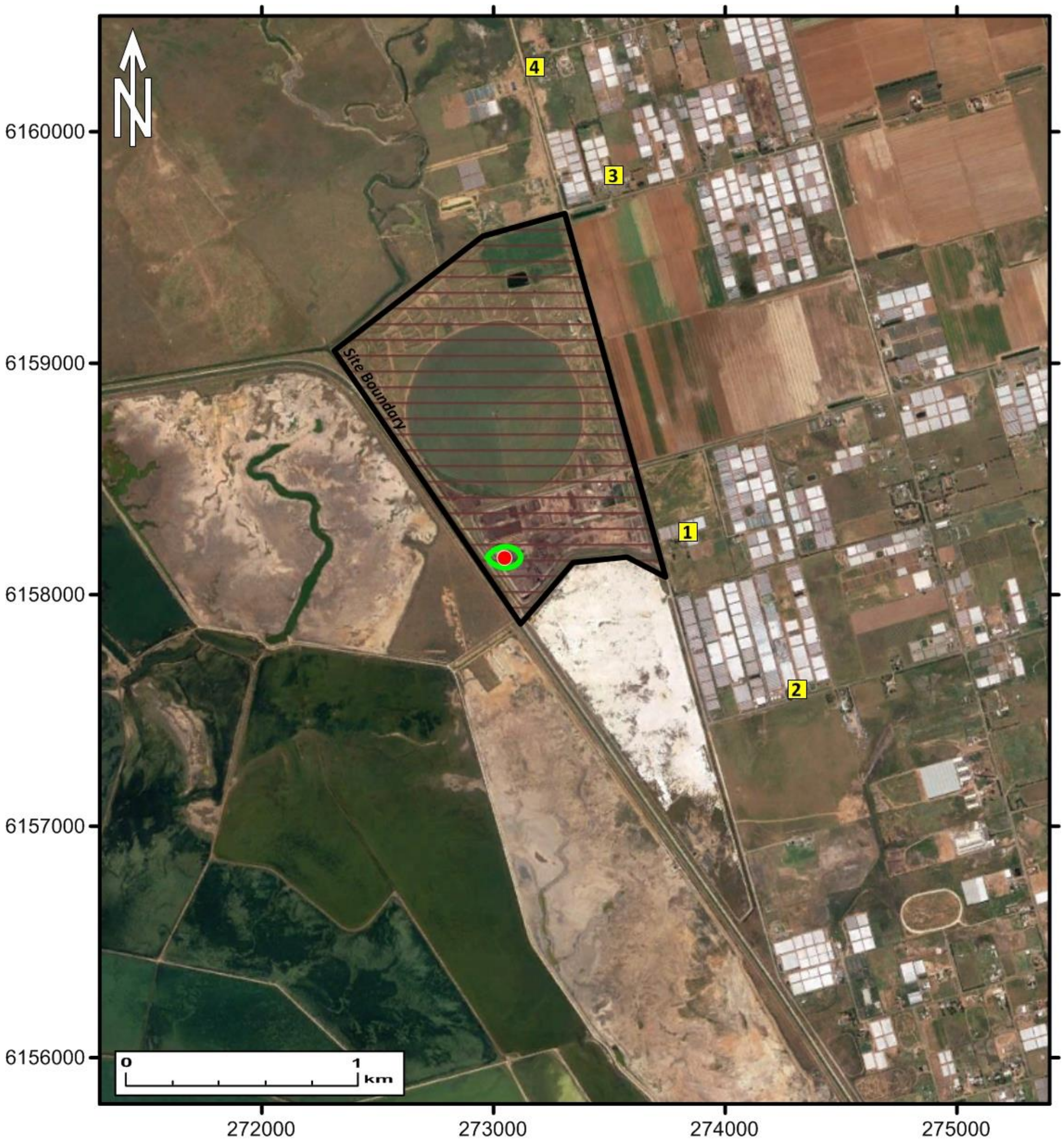


Figure 10 Arsenic (3 minute) glc map.

Contoured at 0.019 µg/m^3
Complies with Schedule 2 glc of 0.19 µg/m^3

Figure 10 shows Arsenic (3-minute) averaging period glc contoured at 0.019 µg/m^3. This is 10% of the Schedule 2 criterion of 0.19 µg/m^3 and is confined to the Jeffries site.

4 References

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Hurley, P.J., Physick, W. L., and Luhar, A. K. (2005). TAPM: a practical approach to prognostic meteorological and air pollution modelling. *Environmental Modelling & Software Issue 20, pp 737-752.*

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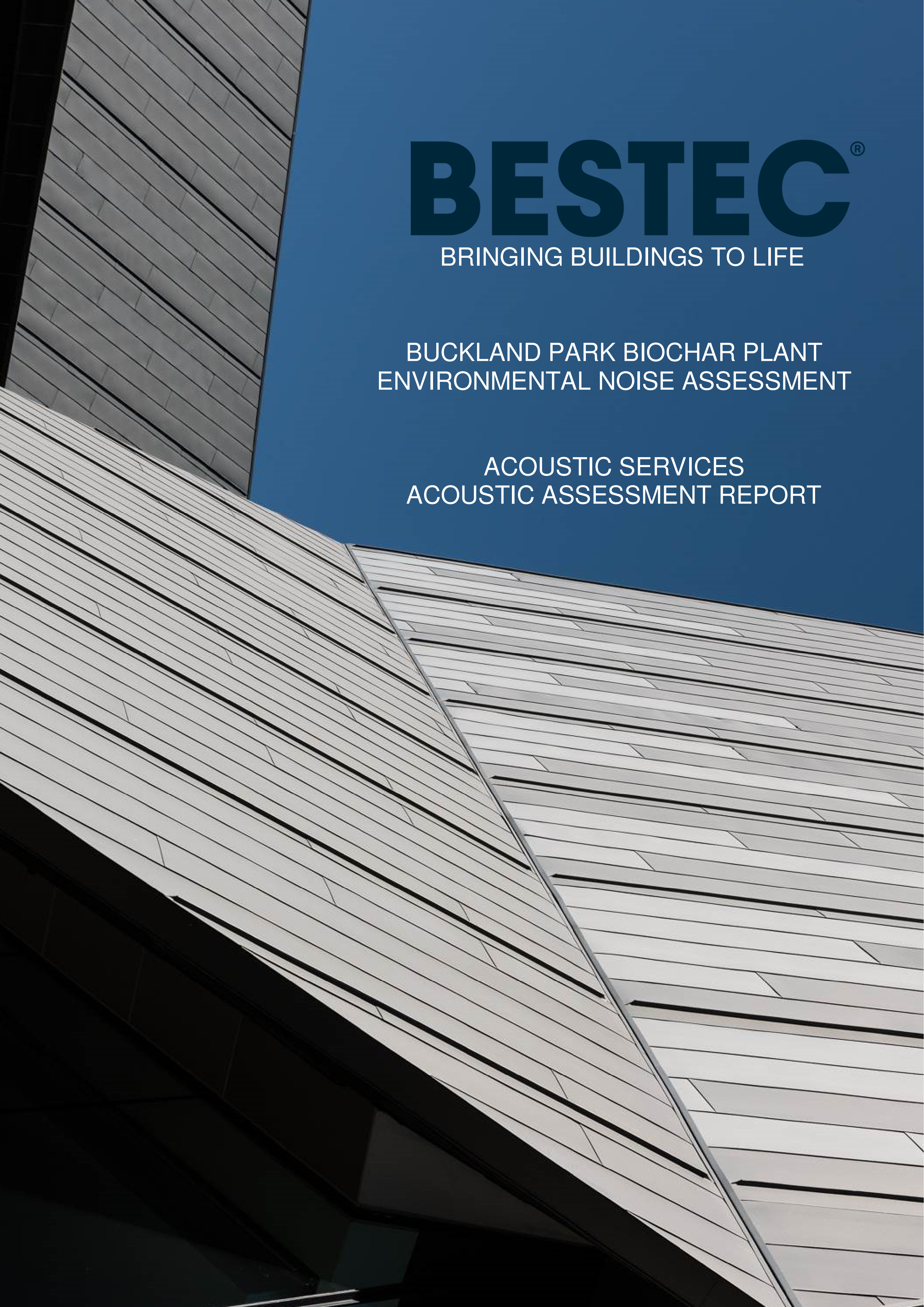
Attachment 2

Noise Assessment Report



BESTEC®

BRINGING BUILDINGS TO LIFE

BUCKLAND PARK BIOCHAR PLANT
ENVIRONMENTAL NOISE ASSESSMENT

ACOUSTIC SERVICES
ACOUSTIC ASSESSMENT REPORT

BESTEC®

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SGA:HAC
56183/6/1
19 December 2018

Rodenburg Waste Solutions
87/220 Greenhill Road
EASTWOOD SA 5063

Attention: Mr R Rodenburg

Dear Sir

BUCKLAND PARK BIOCHAR PLANT – ENVIRONMENTAL NOISE ASSESSMENT
ACOUSTIC SERVICES

As requested, we enclose a copy of our report detailing our assessment of the acoustic conditions for the above project.

We trust that the report provides sufficient information for your immediate purpose and we would be most pleased to further discuss any aspect upon your request.

Yours faithfully

BESTEC PTY LTD

SAKSHAM GARG
ACOUSTIC SERVICES ENGINEER

REPORT ISSUE REGISTER

Report Issue Register				BESTEC
Report Title	Buckland Park Biochar Plant – Environmental Noise Assessment			
Report Type	Acoustic Assessment Report			
Document Number	98249		Project Number	56183
Client	Rodenburg Waste Solutions			

Rev.	Date	Revision Details	Author	Reviewed by
00	19.12.18	Initial Issue	Saksham Garg	Ivailo Dimitrov
01	19.12.18	Revised Issue	Saksham Garg	Ivailo Dimitrov

CONTENTS

Introduction

BESTEC Pty Ltd was engaged to provide acoustic engineering services during the planning approval phase of the new Biochar Plant at the existing composting site at Buckland Park. This document presents the acoustic assessment criteria, results of our assessment and acoustic design recommendations to achieve the stipulated criteria where required.

Executive Summary

In summary:

- The concept site plans were reviewed,
- Attended noise measurements were conducted on site to measure the noise levels from the existing plant equipment/machinery,
- The environmental noise impact associated with the noise emissions from the new cooling tower, ORC Generator, Pyrocal CCT Plant and truck entry/egress and associated loading/unloading activities, to the nearest noise sensitive receiver was assessed,
- Assessment was conducted assuming the worst meteorological conditions (CONCAWE Category 6),
- Acoustic treatment recommendations were provided where required.

For an explanation of the acoustic terms, please refer to the glossary of acoustic terminology attached to this document (Appendix A).

References

The following documents have been referenced within the preparation of this report:

[1] Composting site details provided by Jeffries Group, in their correspondence of 26 November 2018.

[2] Playford Council Development Plan, consolidated 27 June 2017.

[3] SA Environment Protection (Noise) Policy 2007.

[4] Green Thermal Energy Technologies Report, 'ORC Generator and Cooling Tower Potential Emissions for Jeffries Biomass Power Station', dated 03 August 2018.

[5] Pyrocal CCT Systems specifications by Pyrocal Pty Ltd.

[6] Fan data provided by Jeffries Group in their correspondence of 13 December 2018.

[7] Vehicle movements data by Jeffries Group in their correspondence of 06 December 2018.

[8] Heat plant noise data provided by Jeffries Group in their correspondence of 05 December 2018.

[9] Biochar plant information provided by Jeffries Group in their correspondence of 30 November 2018).

Proposed Works

Jeffries Production Site is an existing composting site at Brooks Road & McEvoy Road, Buckland Park, SA 5120, which is currently operational and intends to install a new Biochar plant at the existing composting site.

Attended Noise Survey

An attended noise survey was conducted at Jeffries composting site on 06 December 2018, between 7:00am to 8:30am, to measure the noise levels from the existing plant equipment and machinery. The measurements were undertaken using SVANTEK 953 Type 2 Sound Level Meter (Serial Number: 8951; last calibrated on 19 February 2018; due for calibration on 19 February 2019), with an approved windshield fitted at all times. The calibration of the analyser was spot checked before and after the measurements and no drift was detected.

The noise levels measured during the survey for each equipment/machinery is presented in Table 1 below.

Equipment/Machinery	L_{Aeq}, dB(A)	L_{A10}, dB(A)	L_{A90}, dB(A)	L_{Amax}, dB(A)	Notes
Grinder/crusher with front loader under operation	84.2	85.8	81.4	88	Measured at 45m from the machinery
Compressor plant	67.3	68	64	78.8	Measured at 5m from the plant shed
Recycled Organics Screening System (ROSS)	66.3	68.8	62.2	78.8	Measured at 15m from the machinery

Table 1: Noise levels measured during the survey

Assessment Criteria

Environmental Noise

The Environment Protection (Noise) Policy 2007 (EPP 2007) [3] sets out the maximum allowable noise levels in terms of A-weighted Equivalent Continuous Noise Levels over 15-minute intervals ($L_{Aeq,15min}$) based on the time of day and land use, applicable at the most noise sensitive premises.

For the purpose of our assessment, we have used the criterion provided by EPA for this redevelopment project [9]. The EPA recommends the following maximum noise levels at the Playford Council Horticulture West Policy Area 4:

- Day-time (7:00 a.m. to 10:00 p.m.): 56 dB(A)
- Night-time (10:00 p.m. to 7:00 a.m.): 48 dB(A)

Note that if noise emitted by the proposed development contains any tones, modulation, impulsiveness or low frequency characteristics, the continuous noise level of the noise source must be adjusted as follows:

- Noise containing 1 characteristic – 5 dB(A) penalty added to source continuous noise level;
- Noise containing 2 characteristics – 8 dB(A) penalty added to source continuous noise level;
- Noise containing 3 or 4 characteristics – 10 dB(A) penalty added to source continuous noise level.

Specifications & Assumptions

Plant Noise Levels

Based on the plant specifications provided by Jeffries Group [1] [4] [5], we note that the following new proposed and existing noise generating equipment/machinery and activities:

- Existing
  - 38-off compost aeration fans (FANTEC Model – APCR0312A10/10)
  - Compressor plant
  - ROSS (Recycled Organics Screening System)
  - 1-off grinder[1]
  - Loading/unloading activities (Compost, material loading and unloading of trucks)
  - Truck and front loaders movements
  - Plant personnel/workers activities
- New proposed
  - 1-off 21MWth EVAPCO cooling tower
  - 1-off 355kWe ORC generator
  - Heat plant

To investigate the noise impact to the nearest noise sensitive receivers, we considered the noise levels presented in Table 2 below. Please note that the noise levels for the cooling tower, heat plant and generator were provided by Jeffries Group [4] [5], whereas, noise levels for other activities are based on our measurements conducted at Jeffries composting site and measurements conducted for similar projects.

[1] There are more than 1 grinders on site, however, only one of them operates at any given time on site.

Activity/Equipment/Machinery		Measurement Distance Meters (m)	L_{Aeq}, dB(A)
Truck Movements			
8-Tonne truck take-off		2	74
8-Tonne truck driving past		2	77
8-Tonne truck reversing manoeuvre		6	67
Existing equipment/activities			
Front loader reversing with reverse alarm		6	76
Front loader loading/unloading waste		6	80
Compost Aeration Fans *(1)* *(FANTECH Model - APCR0312A10/10)*		3	76
Compressor Plant		5	67
Recycled Organics Screening System *(ROSS)*		15	66
Grinder		45	84
New equipment/activities			
Cooling Tower *(2)*		1.5	97
ORC Generator *(3)*		1	80
Heat Plant*(3)*	*Oxidiser start-up burner*	1	80
	Hearth start-up burners	1	80
	Auger cooling fans (3-off)	1	74
	Stack	1	77
	ID fan	1	83
	Recirculation pump, lines, sprays	1	75
	Blowdown vent	1	83
	Steam vent	1	77
	Feedwater tank	1	75
	Condensate return steam trap	1	77
	Steam pipe	1	77
Plant Personnel Movements			
Car/Ute pass by *(at 15-20km/hr)*		6	65

Table 2: Summary of noise levels used in our assessment

(1) As advised by Jeffries Group, the 38-off aeration fans, operate24x7.

(2) Cooling tower will be installed outside the proposed new plant building.

(3) ORC generator and heat plant will be housed inside an enclosed sheet metal shed.

Heat Plant & ORC Generator Enclosure Construction

The construction of the enclosure for the heat plant and ORC generator are not known at this stage, however, for the purpose of our assessment, we have assumed the following minimum construction of the enclosure:

- Walls and roof – standard 0.45mm thick, profiled metal sheet walls and roof, with no insulation underneath the roof purlins.
- Door – standard hollow core door with no acoustic perimeter seals.

Vehicle Movements

Based on the existing truck movement data provided by Jeffries Group, in their correspondence of 06 December 2018 [7], we note a maximum of 88 outbound truck trips and a maximum of 75 inbound truck trips to the Buckland composting site. Therefore, for the purpose of our assessment we have considered a worst case of 163 trips (inbound + outbound) at the site.

Please note that, Jeffries Group has confirmed (in their correspondence of 30 November 2018 [9]) that the addition of the new Biochar plant would not result in additional truck movements/trips with.

In addition to above, based on the staff/visitor car movements data [7], we note a maximum of 50 trips (inbound + outbound) at the site.

Jeffries Plant Layout

Based on our observation during the site surveys and the information provided by Jeffries Group, we note the following composting plant layout as shown in Figure 1 below. Please note that the location of the existing plant and the approximate location of the proposed Biochar plant with respect to the noise sensitive receivers (Horticulture West Policy Area 4) have been indicated in the figure below.

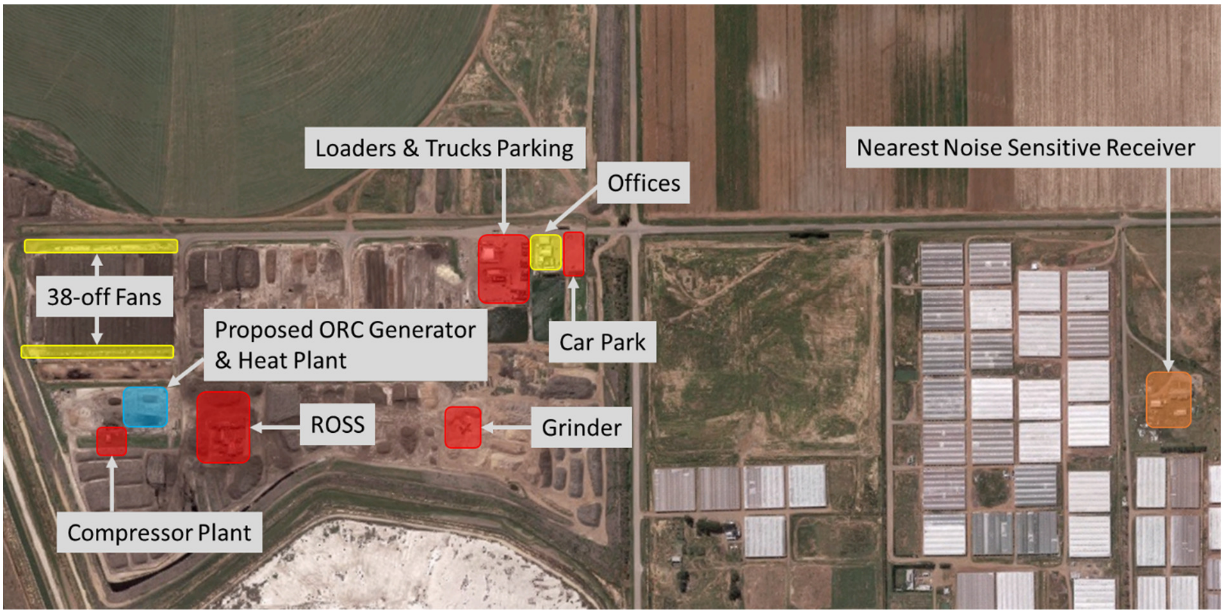


Figure 1: Jeffries composting site – Noise generating equipment location with respect to the noise sensitive receivers

Assessment & Recommendations

Based on the plant specifications provided above and the separation between the noise generating equipment, we predicted the incident noise levels at the nearest noise sensitive receiver at daytime and night-time. Please note that at night-time only the new Biochar plant and the 38-off aeration fans will operate. However, during daytime period, the entire plant equipment listed in Table 2 above operate.

The results of our assessment are presented and compared against the stipulated criterion in Table 3 below:

Time Period	Predicted Incident Noise Levels, dB(A)	Criterion, dB(A)	Compliance
Day time	59	56	***No***
Night time	44	47	***Yes***

Table 3: Assessment results

Results Interpretation

Day-time

We note that the cumulative noise levels at the nearest noise sensitive receiver is marginally exceeded during the day time (3dBA exceedance). We note that a 3dBA increase in sound pressure level would be just noticeable to average human ear, whereas 5dBA change would be quite noticeable. Therefore, the exceedance of 3dBA can be considered acceptable.

Based on our assessment results, we note that noise emissions due to the grinder operation were the dominant source. The *overall incident noise levels without the grinder* in operation were ***46dB(A)***, which is within the stipulated criterion.

In addition to above, we predicted the incident noise levels at the nearest noise sensitive receiver due to operation of only the proposed new Biochar plant. Our assessment reveals incident noise levels of ***37dB(A)*** at the noise sensitive receiver. Therefore, indicating that the noise emissions from the proposed new plant are well within the environmental noise emissions limits and contribute marginally to the existing noise levels.

Also, we note that the grinder (dominant noise source) has been a part of the existing plant/machinery and would not operate during the entire day-period (grinder only operates for intermittent periods). When under operation, we note that the material piled up along the boundary of the composting site, as indicated in the Figure 2 below, act as a natural sound barrier and provide further attenuation to the noise emitting from the grinder.

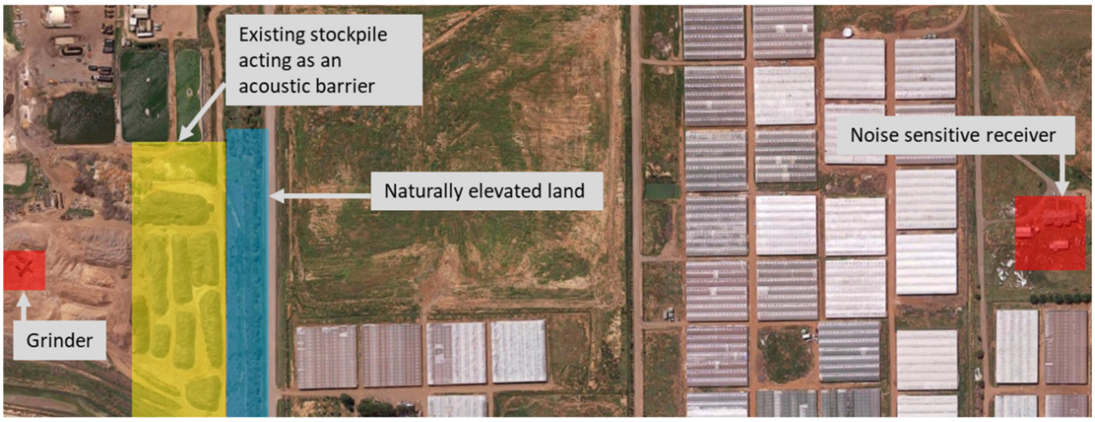


Figure 2: Jeffries composting site

Taking the above into account, we consider the incident noise levels to be *acceptable*.

Night-time

We note that the stipulated night-time criterion is *readily achieved* and therefore, requires no further treatment to control the noise emissions.

Concluding Comments

Based on our assessment, we note that the new Biochar plant would not affect the existing noise levels at the nearest noise sensitive receiver. Our assessment revealed that the grinder was the dominant noise source on site. However, due to its limited operation and considering that the grinder has been an existing equipment on site, we consider that the overall noise levels from the composting should not affect the amenity of the nearest noise sensitive receiver.

Appendix A – Glossary of Acoustic Terminology

dB(A) Also referred to as dBA. A unit of measurement, decibels(A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate human ear response at a loudness level of 40 phons. The table below outlines the subjective rating of different sound pressure levels.

Noise Level (dBA)	Subjective Rating
25-30	Barely audible and very unobtrusive.
30-35	Audible but very unobtrusive.
35-40	Audible but unobtrusive.
40-45	Moderate but unobtrusive.
45-50	Unobtrusive with low levels of surrounding activity.
50-55	Unobtrusive with high levels of surrounding activity.

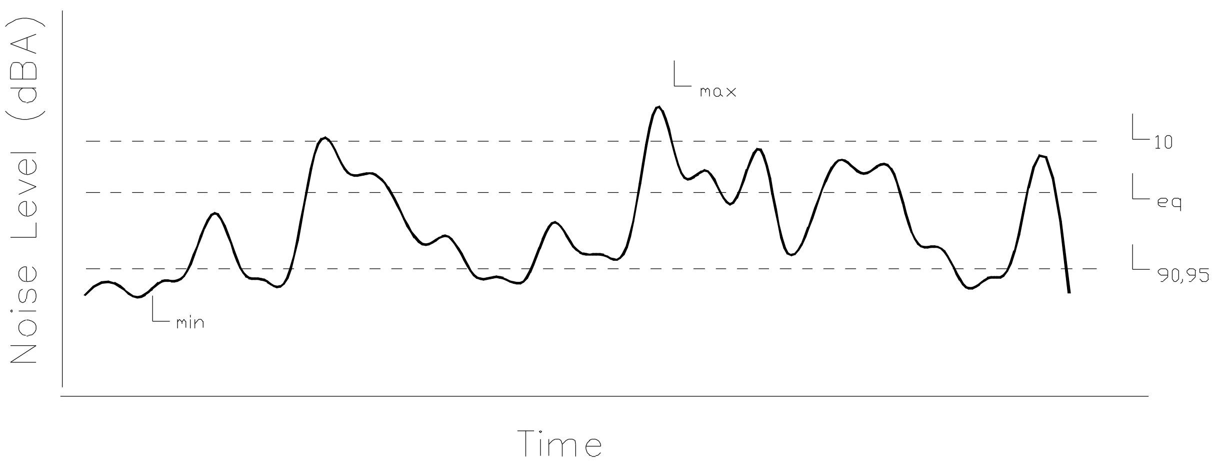
L_1 The noise level which is equalled or exceeded for 1% of the measurement period. L_1 is an indicator of the impulse noise level, and is used in Australia as the descriptor for intrusive noise (usually in dBA).

L_{10} The noise level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and is used in Australia as the descriptor for intrusive noise (usually in dBA).

L_{90}, L_{95} The noise level which is equalled or exceeded for 90% of the measurement period. L_{90} or L95 is an indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise (usually in dBA).

L_{eq} The equivalent continuous noise level for the measurement period. L_{eq} is an indicator of the average noise level (usually in dBA).

L_{max} The maximum noise level for the measurement period (usually in dBA).



Note: The subjective reaction or response to changes in noise levels can be summarised as follows: A 3dBA increase in sound pressure level is required for the average human ear to notice a change; a 5dBA increase is quite noticeable and a 10dBA increase is typically perceived as a doubling in loudness.

STC/R_W Sound Transmission Class or Weighted Sound Reduction Index. Provides a single number rating (from the sound transmission loss or sound reduction index for each frequency band) of the sound insulation performance of a partition. The higher the value, the better the performance of the partition. The subjective impression of different ratings is shown in the table below.

Type of noise source	**STC/Rw Rating**				
	40	**45**	**50**	**55**	**60**
Normal Speech	Audible	Just Audible	Not Audible		
Raised speech	Clearly Audible	Audible	Just Audible	Not Audible	
Shouting	Clearly Audible	Clearly Audible	Audible	Just Audible	Not Audible
Small television/small entertainment system	Clearly Audible	Clearly Audible	Audible	Just Audible	Not Audible
Large television/large hi-fi music system	Clearly Audible	Clearly Audible	Clearly Audible	Audible	Just Audible
DVD with surround sound	Clearly Audible	Clearly Audible	Clearly Audible	Audible	Audible
Digital television with surround sound	Clearly Audible	Clearly Audible	Clearly Audible	Audible	Audible

FSTC/R_W' The equivalent of STC/R_W, unit for sound insulation performance of a building element measured in the field.

C_I, C_{tr} The ratings (R_W, D_{nTw}, L_{nTw}) are weighted in accordance to a spectrum suited to speech. This term modifies the overall rating to account for noise with different spectra, such as traffic (C_{tr}) or footfalls (C_I). The ratings may be written as R_W+C_{tr}, or D_{nTw}/L_{nTw}+C_I.

NNIC/D_{nTw} Normalised Noise Isolation Class, or Weighted Standardised Sound Level Difference. Provides a single number rating of the sound level difference between two spaces and incorporates the effects of flanking noise between two spaces. This rating is generally accepted to be about 5 points less than the STC/R_W rating.

IIC/L_{nw} Impact Insulation Class, or Weighted Normalised Impact Sound Level. L_{nw}=110-IIC. The higher the IIC rating, or the lower the L_{nw} rating the better the performance of the building element at insulating impact noise. The table below gives the subjective impression of different ratings:

IIC	**Lnw**	**Subjective Rating**
40	70	Clearly Audible
45	65	Clearly Audible
50	60	Audible
55	55	Audible
60	50	Just Audible
65	45	Inaudible

FIIC/L_{nTw}' The equivalent of IIC/L_{nw}, but the performance is for the building element measured in the field.

Attachment 3
Green Thermal Energy Technologies Report

Date: 03/08/2018
Author: Paul Keen

gTET

green Thermal Energy Technologies Report

Title: ORC Generator and Cooling Tower Potential Emissions for Jeffries Biomass Power Station

The Jeffries Biomass power station comprises a 355kWe ORC generator, 2.1MWth fibreglass cooling tower and other ancillary equipment including pumps, filters, dosing system etc. A building will be erected over the ORC generator and other electrical equipment.

The areas that could potentially create emissions from this facility are:

i. Cooling tower water, if untreated, can grow bacteria, in particular, legionella.
ii. The cooling tower has an automated and fully monitored chemical dosing system. This system will automatically blow down some water to maintain the set point chemistry.
iii. Maximum cooling tower air flow is $47.5m^3/s$ providing maximum velocities of 4.7m/s.
iv. The fluid used in the fully sealed ORC generators is R245fa, which in the case of leakage could have implications on the immediate area. The MSDS for the fluid rates it as none flammable at ambient temperature and pressures and low toxicity. The product evaporates readily.

Risk management processes will be conducted throughout the project to limit and mitigate any risk associated with the power stations impact on the health of the biodiversity of the local ecosystem including

i. Regular design reviews using cross functional teams to critique all aspects of the power station design
ii. Formal HAZOP to review the power station design for hazards and operability
iii. Supplier reviews to review the component design suitability to meet the system requirements
iv. Factory Acceptance Testing to ensure that the equipment meets the design intent
v. Site commissioning to ensure that the installation meets the design intent.

Controls have been included to address the specific areas that could impact the local ecosystem previously listed, which include, but are not limited to:

i. ORC generator design with zero working seals and minimised sealed joints in order to minimise risk of leakage
ii. Electronic refrigerant sniffer strategically located for the early detection of any working fluid leak and immediately shut down and reduce system pressure upon detection.

iii. Bunded areas for the control of any leakage.
iv. Cooling tower dosing system that is integrated with the site control system to ensure that water treatment is continually monitored.
v. Cooling water blow down will be analysed to ensure that there is no impact to flow into the local waterways at the power station. Typically blow down water just has higher salinity levels.
vi. Cooling water dosing scheme specifically designed for the local water supply and a strict inspection and maintenance routine to ensure water quality is always maintained.
vii. Air flow draft direction and baffle design to minimise air velocities as quickly as possible around the cooling tower and minimise the impact to birds and other wildlife.

viii. The power station is located in excess of 500m from any other property building. The cooling tower produces up to 97dBa @1.5m or 43dBa@500m. The ORC generator emits a maximum of 80dBa at 1m but is installed inside a building which will attenuate noise emissions. Emissions are expected to be less than 60dBa immediately outside the building.
ix. An environmental management plan during construction is being prepared to ensure that construction activities have minimal impact on the local ecosystem.

Cooling tower **ORC Generator**

Attachment 4

Emissions Profile for a Pyrocal Dual CCT Carbonisation System

1 February 2018

PYROCAL Pty. Ltd.

Emissions Profile for a Dual CCT18 Carbonisation system

Pyrocal's Continuous Carbonisation Technology is used to thermally upgrade a wide range of biomass types to biocarbon, often with concurrent heat recovery. This letter outlines the expected emissions for a Dual CCT18 system on several classes of biomass, based on our experience with over 20 installations over the past 10 years.

Typical conversion rates to biocarbon are 20 – 30% by dry weight of biomass. The remaining mass presents as combustible off-gas which is immediately oxidised to clean flue gas (i.e. directly in-line without any intermediate storage). CCT plants do not produce condensate, oil or Pyroligneous acid (wood vinegar) by-products.

Pyrocal CCT systems use a thermal oxidiser as the primary means of emission control. This is located immediately downstream of the carbonisation hearth and is designed to operate with a nominal residence time of two seconds at a temperature of 750 to 920ºC. The function of the oxidiser supplemented by a condensing wet scrubber to achieve applicable particulate, SOx and NOx limits. The figure on the final page of this document outlines the process.

The CCT process also does not generate a wastewater stream. This is achieved by returning solids captured in the condensing wet scrubber back into the biocarbon product, as part of the wet quench.

BIGCHAR systems have been evaluated for licensing in Germany, Wales, California, Canada (Alberta) and New South Wales. Much of this data was confidential to the particular customer, so the table on the following page summarises the expected values for systems. Some of the testing regimes have included evaluation of air emissions of metals, PAH and Dioxins; all of which complied to the relevant requirements.

Regards,

James Joyce BE Chem, MBA, PhD.
Principal Engineer, Pyrocal Pty. Ltd.

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Table 1 Typical Emissions performance of BIGCHAR systems on three classes of biomass

Parameter	Assumed licence limit in SA	Clean woodchip, sawdust, nut shells or fruit pits Low N, S, Cl in feed	Municipal Greenwaste or Rice Hull Moderate N, S and/or Cl	Notes
Total Particulate Matter @ 7% O_2	100 mg/Nm^3	< 75	< 100	Wet scrubber and barrier filter required to achieve TPM<50mg/Nm^3.
Sulphur Dioxide	Not regulated mg/Nm^3	< 10	< 40	Regulated to 50 mg/Nm^3 in parts of EU.
Acid mist as SO_3	100 mg/Nm^3	< 10	< 10	Hydrated lime dosing of feed for high S and Cl feeds.
Total Volatile Organic Compounds (VOC)	40 mg/Nm^3	< 10	< 10	As n-Propane.
Nitrogen Dioxide (NO_2)	350 mg/Nm^3	< 300	< 300	Urea dosing required for high N fuels or where tighter limits are set (e.g. EU)
Carbon Monoxide (CO)	1000 or 125 mg/Nm^3	< 50 At 870ºC oxidiser	< 80 At 825ºC oxidiser	Primarily influenced by oxidiser temp.
Total hydrocarbons (THC)	Not regulated mg/Nm^3	<5	<5	As n-Hexane.
Notes		No NOx control additive required. Thermal oxidiser at 850-920ºC.	NOx control additive usually not required. Thermal oxidiser at 800-850ºC.	
Basis		Tests done in Australia 2010-12, 2016-17 (Black is Green and Pyrocal), UK 2013-15, Germany, 2014-16 and Canada 2014.	Tests done in Australia in 2012 by Black is Green and 2015 by Pyrocal.	Emissions testing by Black is Green Pty Ltd, Pyrocal Pty Ltd and third parties (UK, Canada, Germany and in Australia (MLA, FSA, MJM Enviro.))

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Table 2 Annual Emissions Totals for Dual CCT18 system on Greenwaste

Air Emissions Summary

Model:	Dual CCT18						
			Potential to Emit		**Expected Actual Emissions**		Notes
Basis			353 days/yr @24 hrs/day		288 days/yr @24 hrs/day		
Hours per year			7920		6912		
Nominal throughput tonnes/year of biomass			11760		9677		For an estimate of m^3/year of biomass feedstock multiply by 2.3.
Flue gas, Nm^3 per year			56,448,000		46,448,640		Based on 25% moisture feedstock and exhaust gas:fuel mass ratio of 8:1.
Flue gas, tonne/year			45,158,400		37,158,912		
Pollutant	mg/Nm^3 Note 1	kg/hr	T/year		T/year		
CO	75	0.4	4.2		3.5		
NO_x	200	1.0	11.3		9.3		
SO_x	35	0.2	2.0		1.6		
TSP (ex scrubber)	75	0.4	4.2		3.5		
PM_{10} (ex scrubber)	50	0.2	2.8		2.3		
VOCs	10	0.0	0.6		0.5		

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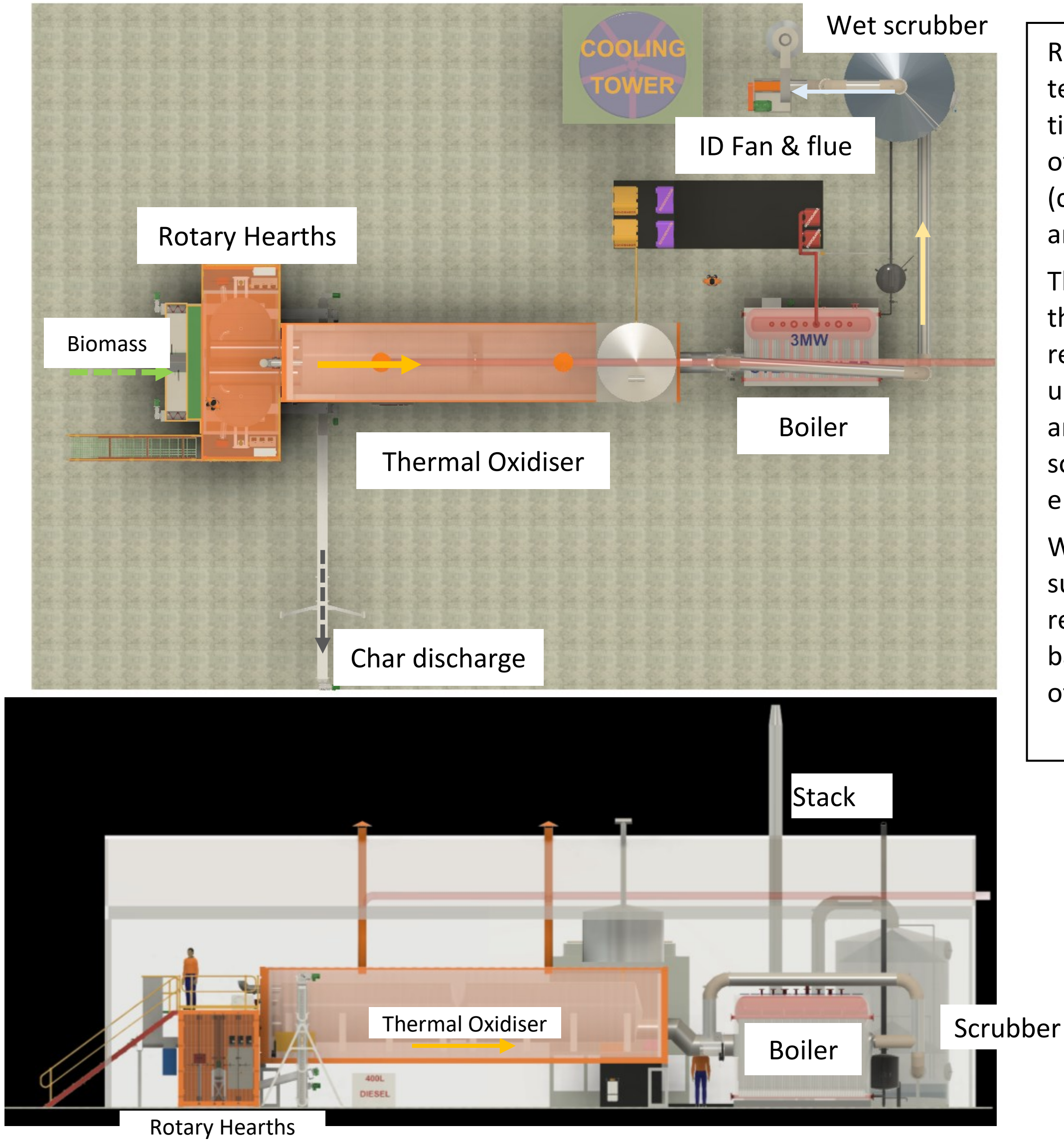


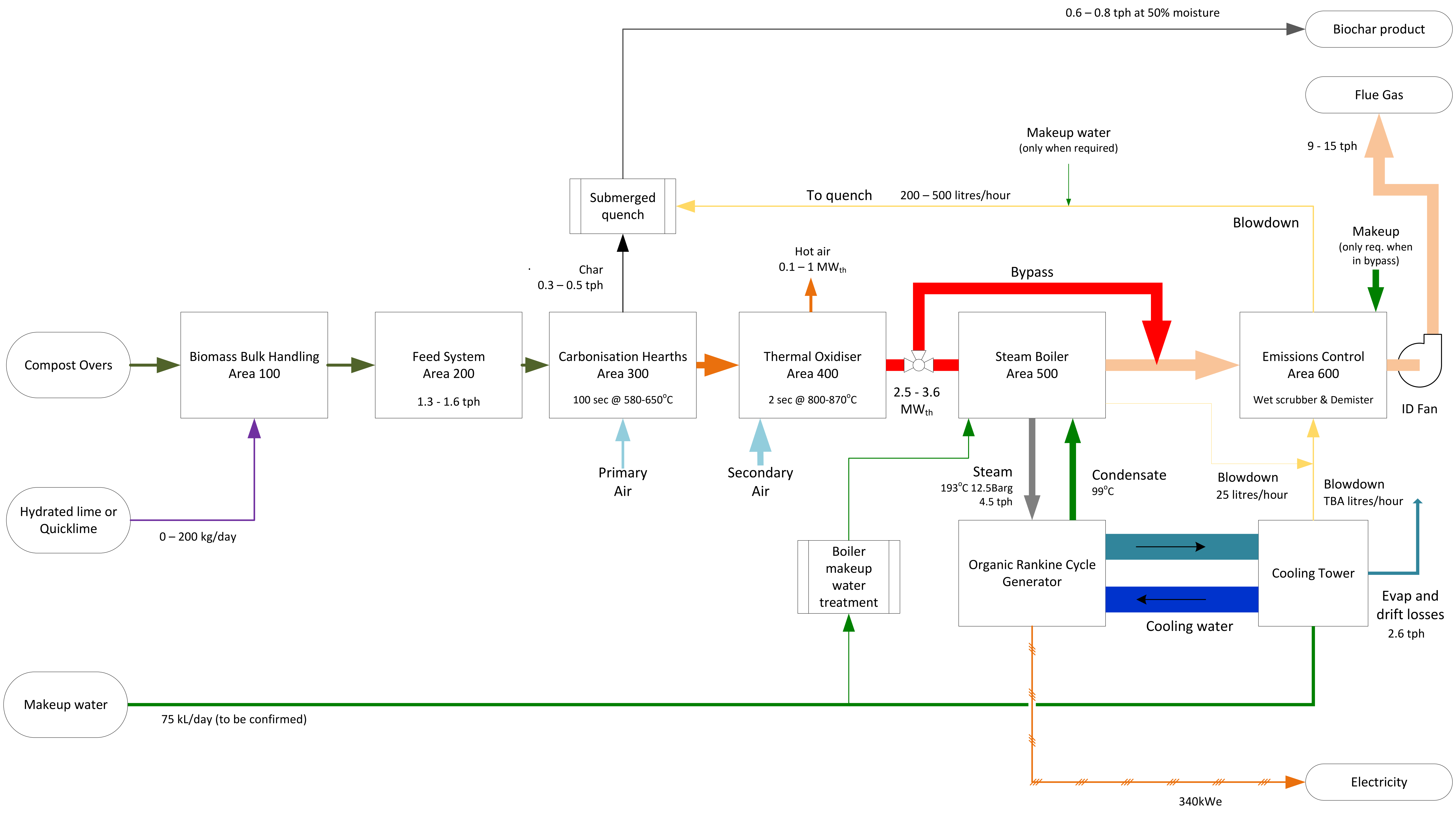
Rotary Hearth: Removes the volatile matter from the biomass at temperatures in the range of 500 to 690°C and a nominal residence time of 100 seconds. This reports to the thermal oxidiser as a mixture of N_2, CO, H_2, other hydrocarbons, SOx, NOx and particulate matter (carbonaceous and inorganic). Most of the potential air pollutants (N, S and metals) are retained in the char product.

Thermal Oxidiser: Combusts the CO, H_2 and remaining organic matter in the off-gas to CO_2 and H_2O, at temperatures of 750°C – 920°C, during a residence time of 2-4 seconds. Where necessary, hydrated lime and/or urea are added upstream of the oxidiser is used to convert NOx to N_2 and convert acid fume, SOx, remaining NOx and volatilised metals to soluble forms for capture in the wet scrubber. The particulate emissions rate of the oxidiser is 200 – 400 mg/Nm^3.

Wet scrubber: >75% of particulate matter and >90% of the soluble sulphur, nitrogen and metal compounds are removed by contact with a recirculating scrubber liquor. The accumulated residues are blended back into the outgoing char as a slurry. The particulate emissions rate of the scrubber is 40 – 100 mg/Nm^3

Figure 1 Equipment Layout and Process Description

Attachment 5
Pyrocal Flow Chart



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