Soukutsu Pty Ltd

1290 Greendale Road River Gardens Cemetery
Air Quality Assessment

May 2021

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1. Introduction

1.1 Background

Soukutsu Pty Ltd ATF Wallacia Trust (Soukutsu) engaged GHD Pty Ltd (GHD) to undertake an air quality assessment to provide the relevant documentation in support of a Development Application (DA) to Liverpool City Council.

The subject of the DA is a proposed development comprising of the demolition of existing structures and construction of a cemetery, crematoria, community facilities, administration buildings, halls, chapels and other buildings and structures all associated with the operation of a cemetery with a garden, parkland and landscape setting. The proposal also includes internal roads, lakes and ponds.

Emissions to air from the project will be associated with operation of the crematorium, and as such this air quality assessment investigates potential air quality impacts from operation of the crematorium only.

1.2 Purpose of this report

Purpose of this report is to prepare an air quality assessment at DA stage for the proposed development which will accompany the DA application to Liverpool City Council.

1.3 Scope and limitations

The scope of works is described below:

- Review relevant client supplied information including cremator details, design and operating conditions
- Review local terrain, meteorology and sensitive receptors
- Process meteorological data for use in dispersion modelling assessment
- Prepare an emissions inventory for operation of the crematorium for relevant pollutants
- Conduct dispersion modelling for one operational scenario of the proposal to determine ground level pollutant impacts at sensitive receptors
- Prepare an air quality assessment in accordance with NSW EPA's Approved Methods for the Modelling and Assessment of Air Pollutants (revised 2016, published 2017), Technical Framework for the Assessment and Management of Odour from Stationary sources in NSW produced by the Department of Environment and Conservation November 2006, administered by the NSW Environment Protection Authority.

The report is subject to the following limitations.

This report: has been prepared by GHD for Soukutsu Pty Ltd and *may only be used and relied on by Soukutsu Pty Ltd for the purpose agreed between GHD and the Soukutsu Pty Ltd as set out in section 1.2 of this report.*

GHD otherwise disclaims responsibility to any person other than Soukutsu Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation

to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.4. of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Soukutsu Pty Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of pollutants in the air) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.4 Assumptions

- HCS Industrial Pty Ltd and MKD Architects provided the stack parameters and emissions from a reference crematorium to be assessed from the proposed cremator stack
- For the purposes of dispersion modelling, meteorological observations measured at the Bureau of Meteorology (BOM) Automatic Weather Station (AWS) at Badgerys Creek are sufficiently representative of the meteorological conditions at the proposal location
- Emission sampling provided by HCS Industrial Pty Ltd for a similar operating B&L Cremation Systems is assumed to be representative of the proposed cremators. HCS Industrial Pty Ltd advised GHD that emissions across the range are similar based on design specifications and operating conditions
- GHD has conservatively used a 1.0 m diameter stack and lower velocity in the air quality assessment compared to the updated drawings which show a 0.4 m stack, this would result in significantly reduced initial plume rise and therefore increased ground level pollutant concentrations.

2. Project description

2.1 Project overview and location

The Statement of Environmental Effects (SEE) for the Development Application (SJB Planning, 2020) states that the proposal consists of a Concept and Stage 1 DA seeking consent to undertake works for the development of a cemetery (River Gardens Cemetery) and associated structures and facilities at 1290 Greendale Road, Wallacia ('the site'). The site is shown in Figure 2-1.

The Concept DA proposal is for the construction of a cemetery including mausoleums, crematoria, chapel, hall, gatehouse, administration buildings, café / florist, onsite parking, access roads and associated on-site parking, bulk earthworks and associated flood management works.

Emissions to air from the project will be associated with operation of the crematorium, and as such this air quality assessment investigates potential impacts from operation of the crematorium only.

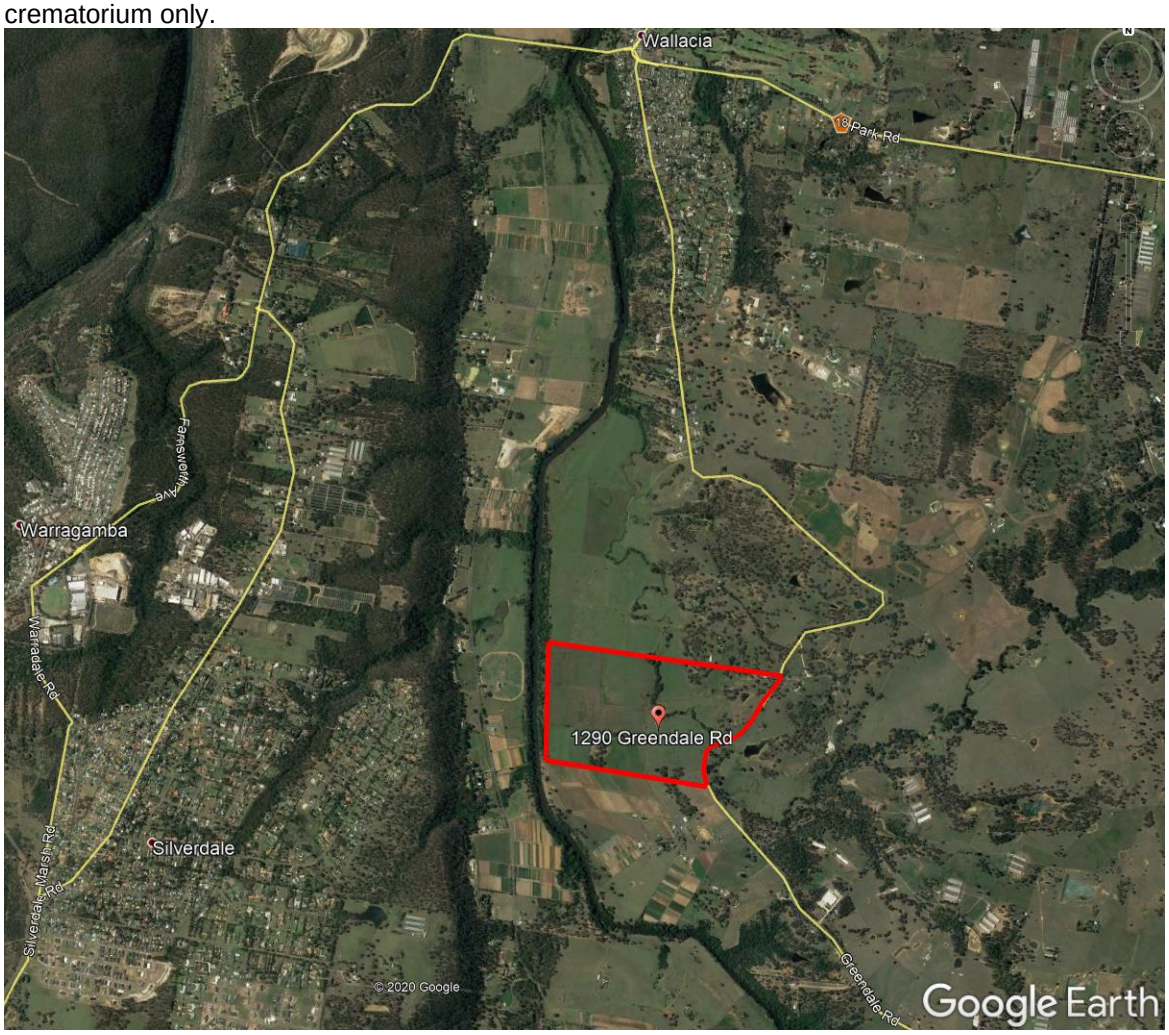

Figure 2-1 Location of proposed development site

2.2 Crematorium features

The proposed crematorium is a large building with a surface area of approximately 1,000 m^2 and is to be a congregational space to facilitate remembrance and ritual of passing. The proposed building is a contemporary design and incorporates cremation plant, stack and associated facilities (refer Figure 2-2 for indicative drawing of building). The building has a maximum capacity of 300 people.

The crematorium has three cremators which are to be supplied by HCS Industrial Pty Ltd (B&L Cremation Systems Australian representative) with the details outlined in Table 2-1.

The features of the crematorium used in this assessment, were provided by HCS Industrial Pty Ltd and MKD Architects. The cremator has a second chamber to treat any pollutants and odours which has a temperature above 850°C and a residence time of 2 seconds, as is considered best practice.

The proposed design meets Australian Cemeteries and Crematoria Association recommendations that the stack outlet should be designed to allow for a stack velocity of at least 8 m/s[1] and that the stack be no less than 3 m above the peak of the roof.

Table 2-1 Overview of the proposed cremators

Parameter	Comment
Cremator type	B&L cremation systems unit (Phoenix II-1 or similar)[2] (Appendix A)
Number of cremators	3
Operational sequence	12 cremations per day, 4 per cremator. 1 cremator operating at a time as services will be staggered.
Hours of use	8 am to 8 pm
Cremator fuel	Gas
Cremator time	Up to 90 minutes (typically less than 60 minutes)
Operating temperatures	Primary chamber – 850 – 950 °C Secondary chamber - > 850 °C
Residence time in secondary chamber	Greater than 2 seconds
Stack details	1 common stack, above building roof as per design drawings Stack height of 15.9 m and diameter of 0.4 m (as per supplied drawings)
Building details	As per drawings provided by MKD Architects (Appendix B)

[1] The provided emissions sampling (refer Section 5.1) outlines a volumetric flow rate of 1.4 m^3/s (at actual stack exhaust conditions) which equals 8 m/s with a 0.4 m diameter stack

[2] Phoenix II-1 Crematory - B&L Cremation Systems, Inc. (blcremationsystems.com)

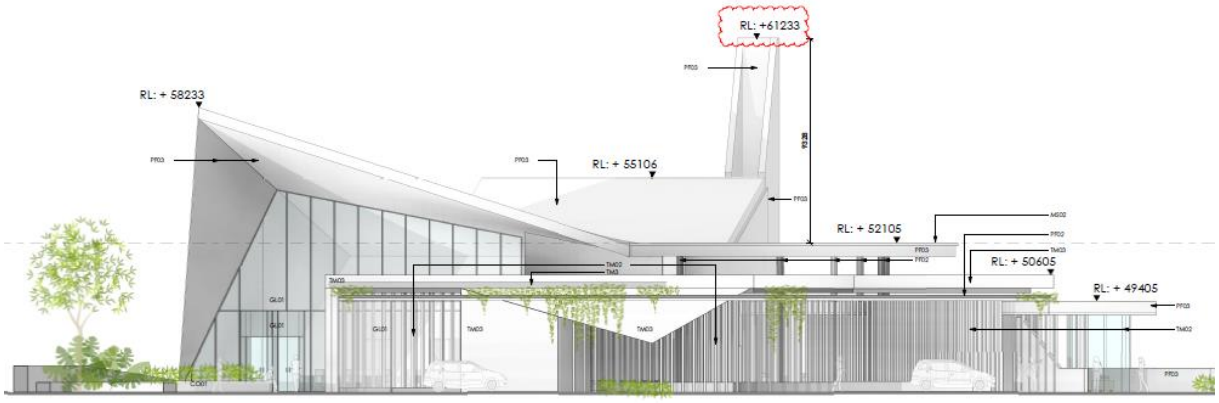

Figure 2-2 Drawing of crematorium southern elevation (Source: MDK Architects)

2.3 Expected emissions to air

Potential emissions to air from the cremation process have been identified through a review of documents and stack sampling data from a similar cremator provided by the equipment supplier.

- Stack sampling report for crematorium with B&L Cremation Systems cremator (Ektimo, 2017) (confidential data)
- National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Crematoria (NPI, 2011)
- Australian Cemeteries and Crematoria Association (ACCA) Environmental Guidelines for Crematoria and Cremators (ACCA, 2004)
- Audit report Crematoria industry sector (South Australia EPA, 2016)

Based on a review of these documents, potential emissions from the cremators are listed in

Table 2-2. Odour impacts are not likely for a well-functioning cremator with an afterburner that incinerates waste gases to ensure smoke, odour and other emissions are minimised. Additional discussion is provided in Section 3.5 about a study of cremators and best practice in Australia, which states that odour is not a high risk emission from cremators and therefore odour (that is a complex mix of odorous pollutants defined in Technical Framework for the Assessment and Management of Odour from Stationary sources in NSW) is not assessed in any more detail in this assessment.

Table 2-2 Typical emissions from cremators

Particulate matter (PM_{10})
Carbon monoxide
Oxides of nitrogen
Oxygen
Sulfur dioxide
Chlorine
Acid gases (as HCl)
Hydrogen chloride

Total fluorine (as HF),
Heavy metals (type 1 & 2 metal substances); including Mercury, Lead, Cadmium, Arsenic, Chromium III (total chromium reported), Chromium VI (hexavalent chromium), Nickel, Antimony, Beryllium, Copper, Zinc
Formaldehyde
Acetaldehyde
Polychlorinated Dioxins and Furans (WHO 05 TEQ)
Polycyclic Aromatic Hydrocarbons (PAHs as BaP-TEQ)

As per Section 3 of the Approved Methods, EPA's preferred method for estimating emissions is direct measurement for existing sources and manufacturers design specifications for proposed sources. HSC Industrial Pty Ltd have provided emissions sampling (email from Tim Barlow from HSC Industrial Pty Ltd dated 19/04/2021) for a machine typical of all Phoenix range cremators. This data is recent (2017 and is considered appropriate for use in this air quality assessment. Emissions are discussed in more detail in Section 5.

3. Regulatory requirements

3.1 Commonwealth Legislation

The National Environment Protection Council (NEPC) has established uniform standards for ambient air quality concentrations and air toxics concentrations in Australia. These standards are known as the National Environment Protection (Ambient Air Quality) Measure (NEPM AAQ) and then National Environment Protection (Air Toxics) Measure (NEPM Air Toxics), which set non-binding air quality objectives and ten-year goals.

NEPM AAQ outlines maximum concentrations for the key pollutants listed in section 2.3, PM_{10}, NO_2, SO_2, CO and lead. The 10-year goal for each pollutant outlined in NEPM AAQ, provides in some instances a maximum number of allowable exceedances of the maximum concentration per year.

3.2 NSW legislation

The POEO Act requires that no occupier of any premises causes air pollution through a failure to maintain or operate equipment or deal with materials in a proper and efficient manner. The operator must also take all practicable means to minimise and prevent air pollution (sections 124, 125, 126 and 128 of the POEO Act).

The *Protection of the Environment Operations (Clean Air) Regulation 2010* (Clean Air Regulation) (POEO Clean Air Regulation) provides regulatory measures to control emissions from wood heaters, open burning, motor vehicles and fuels and industry.

Crematoria are a non-scheduled activity and are required to meet requirements of Schedule 6 of the Clean Air Regulation which includes solid particles and smoke.

3.3 Impact assessment criteria

The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales ('the Approved Methods') (EPA, 2016) lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW. The assessment criteria for pollutants is applied at the nearest existing or likely future off-site sensitive receptor for pollutants in Table 3-1 and at the site boundary for toxic pollutants in Table 3-2.

Table 3-1 NSW EPA impact assessment criteria

Pollutant	Averaging period	Criterion (µg/m^3)
Sulphur dioxide (SO_2)	10 minutes	712
	1 hour	570
	24 hours	228
	Annual	60
Nitrogen dioxide (NO_2)	1 hour	246
	Annual	62
Lead (Pb)	Annual	0.5
Particulates (as PM_{10})	24 hours	50
	Annual	25
Particulates (as PM_{10})	24 hours	25
	Annual	8
Particulates (as TSP)	Annual	90
Hydrogen fluoride (HF)	90 days	0.25
	30 days	0.4
	7 days	0.8

	24 hours	1.5
Carbon monoxide	15 minutes	100,000
	1 hour	30,000
	8 hours	8,000

Table 3-2 NSW EPA impact assessment criteria – principal toxic air pollutants

Pollutant	Averaging period	Criterion (µg/m^3)
Chlorine & compounds excluding HCL	1 hour	50
Acid gases (as HCL)	1 hour	140
Mercury inorganic	1 hour	0.18
Cadmium	1 hour	0.018
Arsenic	1 hour	0.09
Chromimum III (total chromium reported)	1 hour	9
Chromium VI (hexavalent chromium)	1 hour	0.09
Nickel	1 hour	0.18
Acetaldehyde	1 hour	42
Antimony	1 hour	9
Beryllium	1 hour	0.004
Copper	1 hour	3.7
Formaldehyde	1 hour	20
Dioxins and Furans	1 hour	0.000002
PAHs (as Bap-TEQ)	1 hour	0.4
Zinc	1 hour	18

3.4 In-stack emission limits

As described in Section 3.2, emission limits are provided in the POEO (Clean Air) Regulation for particulates and smoke. The Australian Cemeteries and Crematoria Association (ACCA) Environmental Guidelines for Crematoria and Cremators (ACCA, 2004) outlines industry adopted limits to control emissions to air from cremators. The United Kingdom Department for Environment Food and Rural Affairs (DEFRA) has produced Process Guidance (PG) Note 5/2 (12) which outlines statutory guidance for crematoria operating in the UK (DEFRA, 2012). Adopted emission limits from these two sources for expected pollutants are provided in Table 3-3. Where limits are not provided in the Clean Air Regulation, the most stringent criteria of other guidance have been selected.

Table 3-3 Adopted in stack emission limits

Pollutant	In stack limit (mg/m^3)	Reference conditions	Source
Particulates	100	Dry, STP, 3% O_2	POEO Clean Air Reg
Carbon monoxide	100	Dry, STP, 7% O_2	DEFRA
Nitrogen oxides (as NO^2)	500	Dry, STP, 7% O_2	ACCA
Chlorine and compounds	30	Dry, STP, 7% O_2	DEFRA
Acid gases (HCl)	200	Dry, STP, 7% O_2	ACCA
Fluorine and compounds (HF)	50	Dry, STP, 7% O_2	ACCA
Total organic compounds (hexane)	20	Dry, STP, 7% O_2	DEFRA
Heavy metals (total Cd, Cr, Ni, Co, As and Hg)	10	Dry, STP, 7% O_2	ACCA
Mercury	0.05	Dry, STP, 7% O_2	DEFRA
Lead	10	Dry, STP, 7% O_2	ACCA
Cadmium	3	Dry, STP, 7% O_2	ACCA

Polychlorinated dioxins and furans (PCDD/PCDFs);	0.1 ng/m^3	Dry, STP 11% O_2	DEFRA

3.5 Best available technology

South Australia EPA conducted an Audit Report of the Crematoria industry sector in 2016[3], which is the most recent Australian publication outlining the state of the industry and best practice requirements in order to minimise emissions. Key findings of the audit relevant to this proposal include:

- All cremators operating at the time of the audit were noted as emitting minimal smoke and odour, in line with licence conditions
- The audit also found that all cremators designed after 2006 were operated in line with best available techniques and best environmental practice (BAT/BEP) guidance to minimise pentachlorobenzene and other persistent organic pollutants (POPs)
- Afterburner temperatures at or above 850°C are recommended, and form the basis for the BAT/BEP guidance to minimise POPs
- None of the cremators audited use pollution control equipment or other methods to minimise potential mercury emissions. Based on the literature review (Appendix A.2), the EPA does not consider potential mercury emissions from this sector to be a high-risk priority, when considering population, cremation rates, other emitting industries and the phasing down of the use of mercury amalgam fillings in the dental industry.

Based on findings and recommendation of this audit, installing a new cremator, that meets minimum temperature requirements (850°C and 2 second residence time) is considered best practice. Odour impacts are not likely for a well-functioning cremator with an afterburner that incinerates waste gases to ensure smoke, odour and other emissions are minimised.

[3] https://www.epa.sa.gov.au/files/12405_crematoria_audit_2016.pdf

4. Existing environment

4.1 Topography and land use

The SEE describes the current site as being characterised by its undulating topography and generally falls from north-east (RL 74.52 – existing driveway off Greendale Road) to west (RL 36.77) towards the Nepean River which abuts the western site boundary. The central portion of the site is predominantly flat terrain and is intersected by Duncan Creek.

The proposed site has been designed to respect the existing landforms beyond site boundaries and has been carefully laid out to protect the existing trees to ensure the proposal has minimum visual impact on the landscape.

There are no significant topographical features on the site which have been identified that would significantly influence local dispersion patterns for emissions from the crematorium.

4.2 Meteorology

The nearest meteorological observations are available from the Bureau of Meteorology (BOM) Automatic Weather Station (AQS) at Badgerys Creek, approximately 7.5 km east of the site. Data from the BOM AWS at Badgerys Creek were downloaded for the three year period from 2015 through 2017 (inclusive).

Of critical importance to the dispersion of air pollutants are wind speed and direction, which are measured at a height of 10 m above the ground at the BOM Badgerys Creek AWS. A wind rose, showing the frequency of different wind speeds from each direction is shown for the period in Figure 4-1. The following key features are observed when reviewing the wind rose:

- The mean wind speed is 2.5 m/s
- The general wind pattern is aligned through the southwest-northeast axis
- The most frequent winds are from the southwest
- The most frequent strong (>5 m/s) winds are from the western quadrants
- The most frequent light winds are from the southwest sector and to a lesser extent the north through southeast

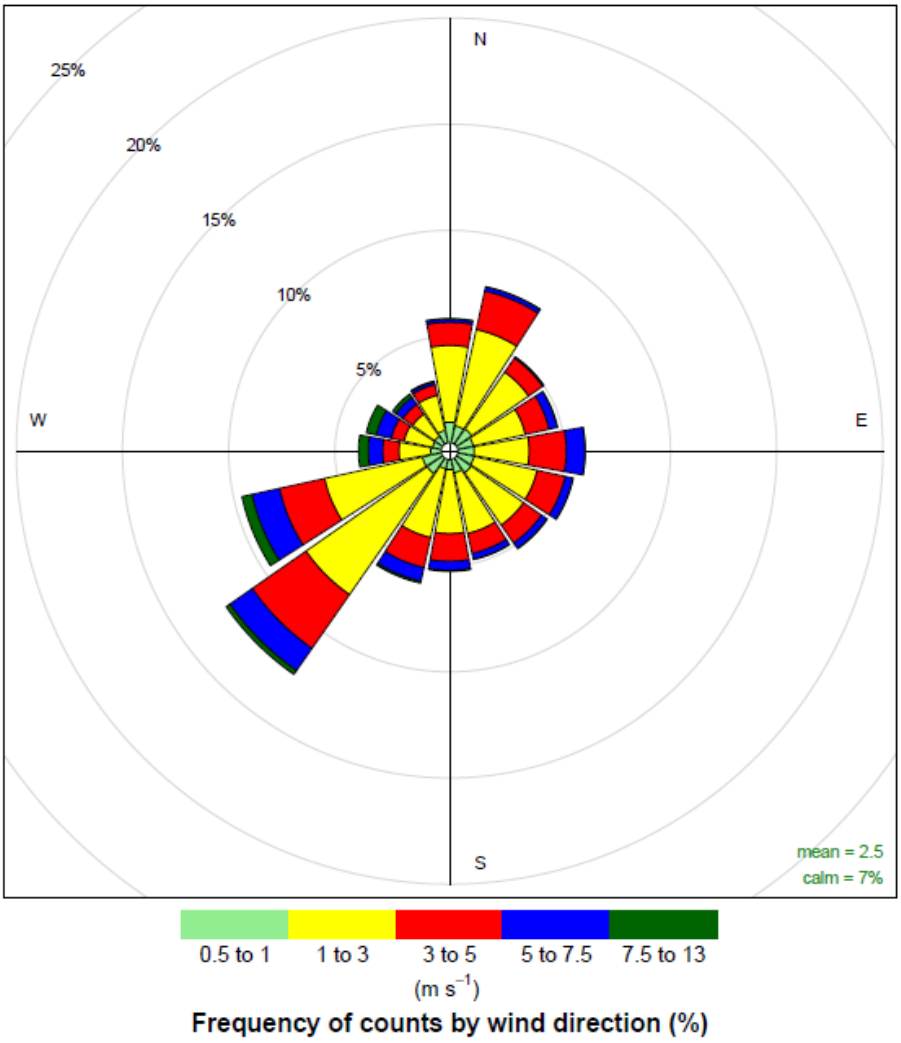

Figure 4-1 Windrose for BOM Badgerys Creek weather station for period 01 January 2015 to 31 December 2017

4.3 Existing air quality

The NSW Department of Planning, Industry and Environment operates ambient air quality monitoring stations (AQMS) in selected areas around NSW. Data was obtained from the nearby Bringelly AQMS and is summarised in Table 4-1. Pollutants relevant to the project which are measured at Bringelly AQMS are:

- Nitrogen dioxide (NO_2)
- Sulphur dioxide (SO_2)
- Particulate matter ($PM_{2.5}$ and PM_{10})

Daily particulate data ($PM_{2.5}$ and PM_{10}) was filtered to remove any measured concentrations already above the impact assessment criteria. The maximum concentration from all three years for all measured pollutants has conservatively been used as the background for the cumulative assessments.

The Bringelly AQMS does not measure all pollutants, as is often the case in NSW due to negligible ambient concentrations. For the purpose of this assessment, the concentrations of all other pollutants has been assumed to be negligible in the impact assessment.

Table 4-1 Background air quality at Bringelly AQMS

Pollutant	Ave period	Criterion	2015	2016	2017
PM_{10}	24 hours	50	37.4	40.4	44.0[4]
	Annual	25	15.8	16.9	19.8
$PM_{2.5}$	24 hours	25	-	21.6	21.8
	Annual	8	-	7.6	7.5
SO_2	1 hour	570	18.3	15.7	23.6
	24 hour	228	2.6	5.2	5.2
	Annual	60	0.4	0.5	0.6
NO_2	1 hour	246	50.8	56.4	67.7
	Annual	62	6.9	8.5	8.6

4.4 Sensitive receptors

Sensitive receptors have been identified based on a review of aerial photography and nearest receptors in each general direction from the stack are identified in Table 4-2. The cemetery grounds are also considered a receptor as future users of the grounds can be impacted by any emissions from the stack. Any assessed ground level pollutant concentrations should therefore be based on the worst-case predicted levels on the whole modelling domain (maximum ground level concentration).

Table 4-2 Representative sensitive receiver locations

Receiver ID	Receiver address	Receiver type	Approximate distance from the proposal stack, m
R1	639 Greendale Rd, Wallacia	Residential	400
R2	1308 Greendale Road, Wallacia	Residential	200
R3	385 Bents Basin Road, Wallacia	Residential	1200
R4	1176 Greendale Road, Wallacia	Residential	800
R5	River Gardens Cemetery	Public use	0

[4] Data excluded on 15/08/2017 – PM10 value 49.5 as assumed to be smoke as PM2.5 was 29.2
Data excluded on 23/09/2017 – PM10 value 49.4 as a dust episode reported in NSW

5. Emissions to air

5.1 Emission sampling

Emissions to air from the stack sampling of a similar B&L crematory are provided in Table 5-1. Results are for two cremators during normal operations where two caskets were cremated during each sample. As sampling was undertaken to verify compliance with the Development Approval, it is assumed that sampling results represent typical emissions for the cremation process which generally lasts up to 90 minutes per cremation.

In stack pollutant concentration results are presented as the Actual measured values and also corrected for oxygen content for comparison with the Standards of Concentration for Non-scheduled Premises (POEO Clean Air Regulation) and the Emission Standards for Crematorium Furnace Facilities (ACCA, 2009).

All measured in stack pollutant concentrations are below the relevant limits, indicating the cremators readily comply with the requirements. As a conservative measure, the maximum value for of the two samples for each pollutant has been used for modelling of the proposed cremators.

Table 5-1 Sampled pollutant concentrations during cremation (Ektimo, 2017)

Parameter	Actual concentration (mg/m^3)		Concentration corrected for oxygen (mg/m^3)	
	C1	C2	C1	C2
Fine particulates (PM_{10})	14	4.7	29	9.6
Carbon monoxide	17	9.5	27	15
Nitrogen oxides	220	260	340	410
Chlorine & compounds excluding HCL	<0.03	<0.03	<0.04	<0.05
Acid gases (as HCL)	12	10	19	16
Flourine & compounds (as HF)	1.2	2.4	1.8	3.7
Heavy metals (type 1 & 2 substances in aggregate)	<0.054	<0.12	≤0.084	≤0.18
Mercury	<0.005	0.00033	<0.0008	0.00052
Lead	0.0099	0.078	0.015	0.12
Cadmium	<0.001	<0.001	<0.002	<0.002
Arsenic	<0.004	<0.003	<0.006	<0.005
Chromimum III (total chromium reported)	0.0026	0.0037	0.004	0.0059
Chromium VI (hexavalent chromium)	<0.009	<0.009	<0.01	<0.01
Nickel	<0.002	<0.002	<0.003	<0.003
Acetaldehyde	0.052	<0.02	0.081	<0.03
Antimony	0.014	<0.009	0.022	<0.01
Beryllium	0.002	<0.002	<0.003	<0.003
Copper	0.0085	0.0076	0.013	0.012
Formaldehyde	0.046	0.036	0.071	0.056
Dioxins and Furans	7.50E-09	3.60E-09	1.2E-08	5.6E-09
PAHs (as Bap-TEQ)	0.0000095	8.30E-06	0.000015	1.30E-05
Zinc	2.7	0.26	4.3	0.41

Sulfur Dioxide	5.2	21	8.1	33

5.2 Modelled emission rates

Sampling results and flow rates of the sampling discussed in Section 5.1 have been adopted for the proposed cremator configuration. The maximum measured concentration of each pollutant has been used in the assessment. The proposed stack is 1.0 m diameter and 15.8 m height above ground.

Based on advice from HSC Industrial Pty Ltd and MKD Architects, only one cremation would occur at any one time. GHD has modelled the emission rates in being emitted from the stack constantly between 8 am and 8 pm.

Table 5-2 Modelled emission parameters and rates

Stack Name	Crematorium stack		
Discharge Parameter	**Value**	**Unit**	**Source**
Stack height	15.8	m	From drawings supplied by client
Stack diameter	1	m	From drawings supplied by client
Discharge temperature	517	°C	Average of sampling data
Volumetric flow rate	1.25	m^3/s	Average of sampling data
Discharge velocity	1.6	m/s	Derived

Pollutant Emission Rates (g/s)			
Pollutant	**Value**	**Pollutant**	**Value**
Fine particulates (PM_{10})	1.82E-02	Chromium VI (hexavalent chromium)	1.17E-05
Carbon monoxide	2.21E-02	Nickel	2.60E-06
Nitrogen oxides	3.12E-01	Acetaldehyde	6.76E-05
Chlorine & compounds excluding HCL	3.90E-05	Antimony	1.82E-05
Acid gases (as HCL)	1.56E-02	Beryllium	2.60E-06
Flourine & compounds (as HF)	2.88E-03	Copper	1.11E-05
Heavy metals (type 1 & 2 substances in aggregate)	1.44E-04	Formaldehyde	5.98E-05
Mercury	6.50E-06	Dioxins and Furans	9.75E-12
Lead	9.36E-05	PAHs (as Bap-TEQ)	1.24E-08
Cadmium	1.30E-06	Zinc	3.51E-03
Arsenic	5.20E-06	Sulfur Dioxide	2.52E-02

Chromimum III (total chromium reported)	4.44E-06	

6. Impact Assessment

6.1 Method

Air emissions during operation of the crematorium have the potential to lead to air quality impacts. Modelling and assessment has been undertaken in accordance with the Approved Methods with the following general assumptions:

- Three years of background air quality data reviewed and processed from the nearby Bringelly AQMS. Highest values for each measured pollutant have been used for a conservative cumulative assessment.
- Emissions sampling data from a similar operating B&L Cremation Systems cremator has been used in this assessment. The maximum sampled emissions data for each pollutant was used.
- One cremator has been assumed to be operating constantly between 8 am and 8 pm (12 hours)
- Dispersion modelling undertaken as described in Section 6.2
- Dispersion modelling was undertaken for a three year period, with the maximum predicted concentrations (100th percentile) on the modelling grid conservatively used for assessment
- Results compared against the NSW ground level criteria as discussed in Section 3.

6.2 Dispersion model configuration

Air quality dispersion modelling was undertaken using AERMOD, a Gaussian type plume dispersion model developed by the US EPA and adopted by EPA Victoria as the regulatory model in 2014. AERMOD is used in NSW in place of the older Guassian model Ausplume.

AERMOD was configured using the meteorological data as described in section 4.2 and in accordance with EPA Victoria's AERMOD modelling guidance (publications 1550 and 1551)[5].

Building and stack locations are show in Figure 6-1. Key components of the model configuration are summarised below:

- 36-month meteorological data file for the period 1 January 2015 to 31 December 2017 as outlined in section 4.2
- Cartesian receptor grid large enough to include discrete ground level sensitive receptors as outlined in section 4.4
- Site topography and three-dimensional terrain has been used in the model, with 30 m resolution.
- Building wake influences were included in the model configuration for all major buildings at the crematorium. The BPIP Prime algorithm was utilised to calculate building wake effects for the stack source.

[5] EPA Victoria 2013 "Construction of input meteorological data files for EPA Victoria's regulatory air pollution model (AERMOD)" Publication 1550, October 2013

6.3 Assessment results

A tabulated summary of model outputs is presented in Table 6-1 with predicted maximum ground level concentrations presented.

Assessment of the maximum predictions against the adopted impact assessment criteria shows compliance for all pollutants for all averaging periods at all receptors.

Maximum predicted concentrations presented are within the cemetery grounds, pollutant concentrations at receptor locations would be much lower.

The highest risk impact is the maximum 1-hour NO_2 concentration, which is predicted to be 48% of the impact assessment criteria, within cemetery grounds. This conservatively assumes 100% conversion of nitrogen oxides to NO_2 which is unlikely and also that the maximum site impact occurs simultaneously with the maximum background condition.

Table 6-1 Predicted ground level concentrations – NSW EPA air quality standards

Pollutant	Averaging period	Criterion ($\mu g/m^3$)	Maximum predicted incremental value ($\mu g/m^3$)	Background value	Maximum predicted cumulative value ($\mu g/m^3$)
Sulphur dioxide (SO_2)	10 minutes	712	5.9	23.6	29.5
	1 hour	570	4.1	23.6	27.7
	24 hours	228	1.3	5.2	6.5
	Annual	60	0.1	0.6	0.7
Nitrogen dioxide (NO_2)	1 hour	246	50.9	67.7	118.6
	Annual	62	1.8	8.6	10.4
Lead (Pb)	Annual	0.5	0.000526	0	0.000526
Particulates (as PM_{10})	24 hours	50	0.9	44.0	44.9
	Annual	25	0.1	19.8	19.9
Particulates (as $PM_{2.5}$)[6]	24 hours	25	0.9	21.8	22.7
	Annual	8	0.1	7.6	7.7
Hydrogen fluoride (HF)[7]	90 days	0.25	0.14	0	0.14
	30 days	0.4	0.14	0	0.14
	7 days	0.8	0.14	0	0.14
	24 hours	1.5	0.14	0	0.14
Carbon monoxide	15 minutes	100,000	4.8	0	4.8
	1 hour	30,000	3.6	0	3.6
	8 hours	8,000	2.6	0	2.6

[6] Impact conservatively assumed to be equivalent to PM_{10}

[7] Conservatively assumed 24 hour increment for all averaging periods

Table 6-2 Predicted ground level concentrations – principal toxic air pollutants

Pollutant	Averaging period	Criterion (µg/m^3)	Maximum predicted value (µg/m^3)
Chlorine and compounds	1 hour	50	0.0064
Acid gases (as HCL)	1 hour	140	2.5428
Mercury organic	1 hour	0.18	0.0011
Mercury inorganic	1 hour	1.8	0.0011
Cadmium	1 hour	0.018	0.0002
Arsenic	1 hour	0.09	0.0008
Chromimum III (total chromium reported)	1 hour	9	0.0007
Chromium VI (hexavalent chromium)	1 hour	0.09	0.0019
Nickel	1 hour	0.18	0.0004
Acetaldehyde	1 hour	42	0.0110
Antimony	1 hour	9	0.0030
Beryllium	1 hour	0.004	0.0004
Copper	1 hour	3.7	0.0018
Formaldehyde	1 hour	20	0.0097
Dioxins and Furans	1 hour	0.000002	1.59E-09
PAHs (as Bap-TEQ)	1 hour	0.4	2.01E-06
Zinc	1 hour	18	0.5721

R1
R2
R3
R4

1:4,550

100 50 0 100

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

NO_2

- 5 µg/m^3
- 10 µg/m^3
- 25 µg/m^3

Airquality receiver

Stack

1290 Greendale Rd Lot

Buildings

GHD CLIENTS | PEOPLE | PERFORMANCE

Project: 1290 Greendale Road
River Gardens Cemetery

Contour plot of predicted maximum 1 hour NO_2 concentration during operation of the cremator Figure 6-1

Job Number	21-12517741
Revision	C
Date	29 Apr 2021

\\ghdnet\ghd\AU\Sydney\Projects\21\12517741\GIS\Maps\Working\21_12517741_Countours_Working_MF.mxd

Data source: Aerial imagery - Sixmaps 2021 © Department of Customer Service 2020. Created by: mfredle

6/20 Smith Street Parramatta NSW 2150 Australia T: 61 2 8898 8800 W: www.ghd.com.au

7. Conclusion

An air quality assessment has been completed in order to understand the significance of potential air quality impacts associated with emission from operation of the crematorium at the site.

A quantitative assessment of operational air emissions was completed in accordance with the Approved Methods using air dispersion modelling for the proposed cremators.

The assessment included a review of potential emissions from cremation activities and what is considered best practice in Australia. The proposed cremator is to be provided by B&L Cremation Systems (Phoenix II-1 or similar) and the twin chamber system is designed to removes pollutants and odours as per best practice guidance.

Emissions sampling data from a similar operating B&L Cremation Systems cremator has been used in this assessment whereby the maximum sampled emissions data for each pollutant was used.

Operating conditions have been conservatively assumed based on advice from HCS Industrial Pty Ltd and MKD Architects.

The dispersion modelling found that the predicted ground level pollutant concentrations are readily compliant with the adopted impact assessment criteria for all pollutants for all averaging periods.

Given the results of the dispersion modelling assessment, emissions to air during operation of the crematorium within the site are not likely to lead to significant air quality impacts on cemetery ground or at sensitive receptor locations.

8. References

Audit Report Crematoria industry sector (South Australia EPA, 2016)

Australian Cemeteries and Crematoria Association (ACCA) Environmental Guidelines for Crematoria and Cremators (ACCA, 2004)

Environment Protection Authority (2016). Approved Methods for the Modelling and Assessment of Air Pollutants in NSW

Protection of the Environment Operations Act 1997 (NSW)

Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW)

Stack sampling report for crematorium with B&L Cremation Systems cremator (Ektimo, 2017) (confidential data)

National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Crematoria (NPI, 2011)

Appendices

Appendix A – Cremator specification

Length:	3.96 m
Width:	1.83 m (2.13 m with Control Panel)
Height:	2.44 m (2.64 m with Doorcap)
Weight:	14,514.96 kg
Clean Out Door Opening:	0.55 m Width x 0.50 m Height
Door Opening:	1.17 m Width x 0.81 m Height
Gas Pressure:	Natural Gas: 1.74 kPa W.C. Propane Gas: 2.74 kPa W.C.
Power RQMTS:	220 V, Single Phase, 45 AMPS (Available in 3 Phases and 50 Cycle Options) 110 V, Single Phase, 10 AMPS
Body Weight Capability:	453.59 kg
Cremation Rate:	90.72 kg/hr (PHII-1S 113.40 kg/hr)
Stack Height From Grade:	5.49 m
Stack Sections:	76.20 cm O.D.
Chamber Dimensions:	Length: 254 cm Width: 114.30 cm Height: 92.71 cm 2.75 m³
Burner Output:	Afterburner Maximum: 1,055,055.85 kJ per Hour Cremation Burner: 527,527.93 kJ per Hour Ignition Burner: 316,516.76 kJ per Hour Maximum Input Rating: 1,582,583.78 kJ per Hour Modulation Minimum: 105,505.59 kJ per Hour
Air RQMTS:	Outside air inlet louvers in the room located at or below burner height, capable of passing 70.79 m³ per minute of free air.

CONTROL SYSTEM AND POLLUTION MONITORING – This system constantly monitors the stack gases to prevent visible emissions. Integrated with the automatic system, this feature enables the unit to make all necessary adjustments automatically.

FULLY-AUTOMATIC CONTROL SEQUENCE – Operation is made simple by the fully-automatic control sequence. A microprocessor temperature controller with a digital readout ensures optimum control while providing the lowest fuel consumption. Visual verification of each stage is provided on the control panel. Operator override is achieved by a turn of a switch for semi-manual control.

HOT HEARTH DESIGN – First introduced by B&L, this design allows for wasted afterburning heat to be recycled through the floor, eliminating fluid problems, lowering fuel consumption, and extending the hearth life.

HYDRAULIC LOADING DOOR – Push-button operated, this feature enables the operator to open the door to the desired height from the control panel. An important safety feature for busy installations, it provides better fuel efficiency and longer refractory life.

LOW NOISE – The secondary combustion blower has been manufactured and installed to allow for low noise operation.

MULTI-CHAMBER AIR CONTROLLED DESIGN – The entire combustion process is completed within the air controlled chambers, allowing for 24 hour operation, eliminating burning in the stack, and providing for greater fuel efficiency over excess air designs.

REFRACTORY – Our exclusive features are high-duty refractory walls in all chambers and six inch, 3,000 degree Farenheit high-duty bricks in all non-insulating areas. The hearth is cast from 3,000 degree Farenheit abrasive resistant material, and the main chamber ceiling is insulating firebrick to provide better fuel efficiency and longevity.

REFRACTORY LINED STACK – A three inch insulating liner is provided as a safety feature. While gases seldom exceed 1,000 degrees Farenheit, the liner reduces heat penetration under every condition, preventing the possibility of fire. A ten year warranty is offered on the stack liner.

REMAINS REMOVAL SYSTEM – A separate remains removal door, located on the side of the unit, is included to enable the operator to push the remains to the rear of the chamber, reducing heat loss and thermal shock as the loading door needs only to be opened six to eight inches for removal. A stainless steel cooling pan is located on the outside of the unit to prevent fluid contamination.

STAINLESS STEEL FRONT – More than just aesthetics. Stainless steel is easy to clean, while also providing a professional finish to your equipment…an important feature when considering a viewing.

STARTUP – Startup is made easy, as our units are fully piped, tested, and wired prior to shipment from the factory. Once the machine has been off-loaded and the stack and utilities hooked up, our factory-trained crematory technicians are available for startup and training service for up to five people.

TOUCHSCREEN CONTROLS – Our ten inch touchscreen operating system completely controls the cremation process, making less room for user error. Our system also allows you to log in with a username and password before you operate the machine. You may then enter the I.D., name, and weight of the deceased while our storage and retrieval system allows you to keep track of every cremation done. An ethernet cable port, located on the inside door of the control panel, allows you to plug into the Internet and have our crematory technicians troubleshoot any problems you may have right from our facility, no matter where you are in the world.

Appendix B – Project drawings

III. BUILDING TYPES (STAGE 1)

CREMATORIUM

mkd architects
Nominated Architect: Carl Salm 7498
mkdarchitects.com.au

Project Address:
1290 GREENDALE PARK ROAD / WALLACIA
Client:
SOUKUTSU PTY LTD

Project Number:
20971
Project Status:
DA

Drawing Name:
COVER
Drawing Scale @ A1: NTS

Drawing Number:
DA-D4.00
Revision: **A** (NOV 2020)

mkd architects
Nominated Architect: Carl Salm 7498
mkdarchitects.com.au

0 1 2 3 4 5

Project Address:
1290 GREENDALE PARK ROAD / WALLACIA

Client:
SOUKUTSU PTY LTD

Project Number:
20971

Project Status:
DA

Drawing Name:
CREMATORIUM GROUND LEVEL PLAN
Drawing Scale @ A1: 1 : 100

Drawing Number:
DA-D4.01
Revision: B (MAY 2021)

2
DA-D4.02

1
DA-D4.02

CREMATORIUM STACK

RL: +52814

RL: +52105

16.69°
SLOPE

VOID

VOID

RL: +48900

RL: + 52105

RL: +45300

RL: + 52300

RL: +49550

RL: +45300

TURNING BAY

16.77°
SLOPE

9.53°
SLOPE

19.83°
SLOPE

2
DA-D4.02

1
DA-D4.02

mkd architects
Nominated Architect: Carl Salim 7498
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0 1 2 3 4 5

Project Address:
1290 GREENDALE PARK ROAD / WALLACIA

Client:
SOUKUTSU PTY LTD

Project Number:
20971

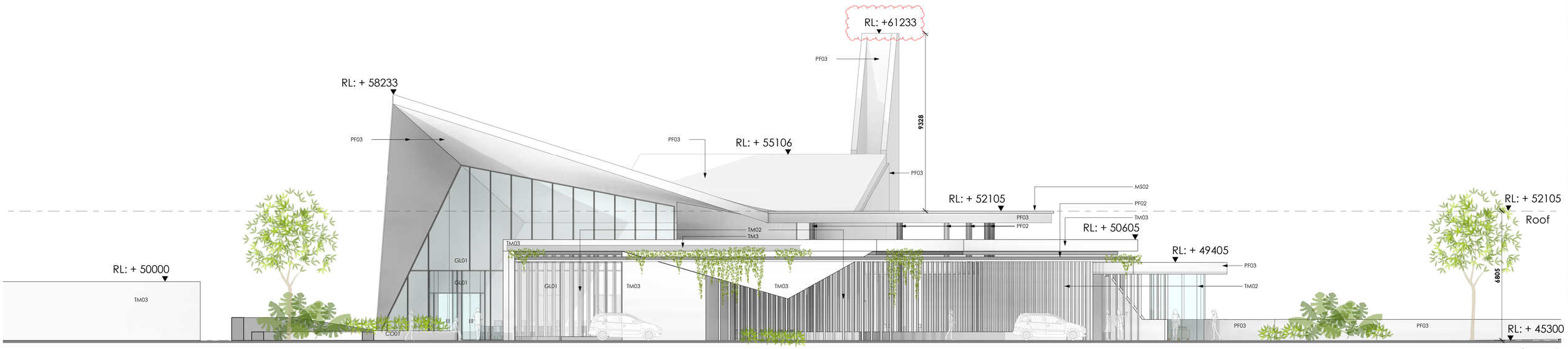
Project Status:
DA

Drawing Name:
CREMATORIUM ROOF PLAN

Drawing Scale @ A1: 1 : 100

Drawing Number:
DA-D4.02

Revision: **A** (NOV 2020)



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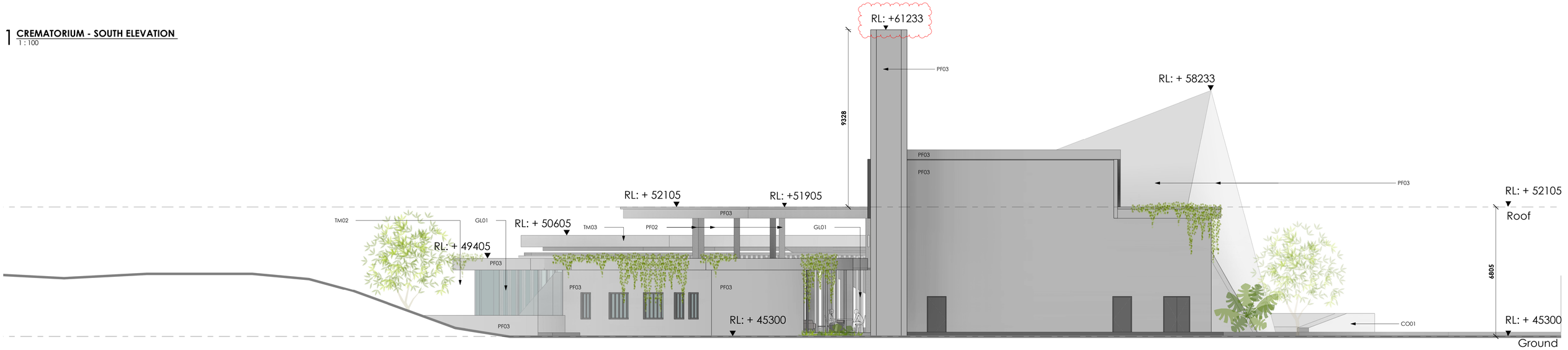

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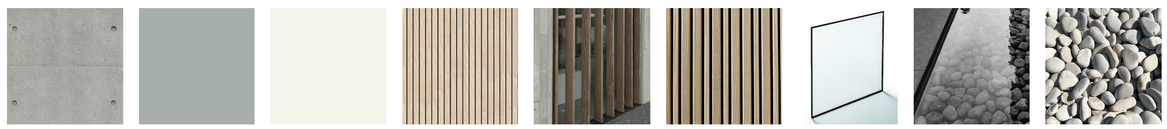

CO01
OFF-FORM CONCRETE

PF02
DULUX ALPHATEC BRIGHT SILVER - METALLIC POWDERCOATED PAINT FINISH

PF03
DULUX ALPHATEC WHITE - MATT PAINT FINISH

TM01
TIMBER DECK FINISH

TM02
TIMBER FINS

TM03
TIMBER CLADDING

GL01
CLEAR TOUGHENED GLASS

MS01
WATER FEATURE

MS02
PEBBLES

mkd architects
Nominated Architect: Carl Sidey 7499
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0 1 2 3 4 5

Project Address:
1290 GREENDALE PARK ROAD / WALLACIA
Client:
SOUKUTSU PTY LTD

Project Number:
20971
Project Status:
DA

Drawing Name:
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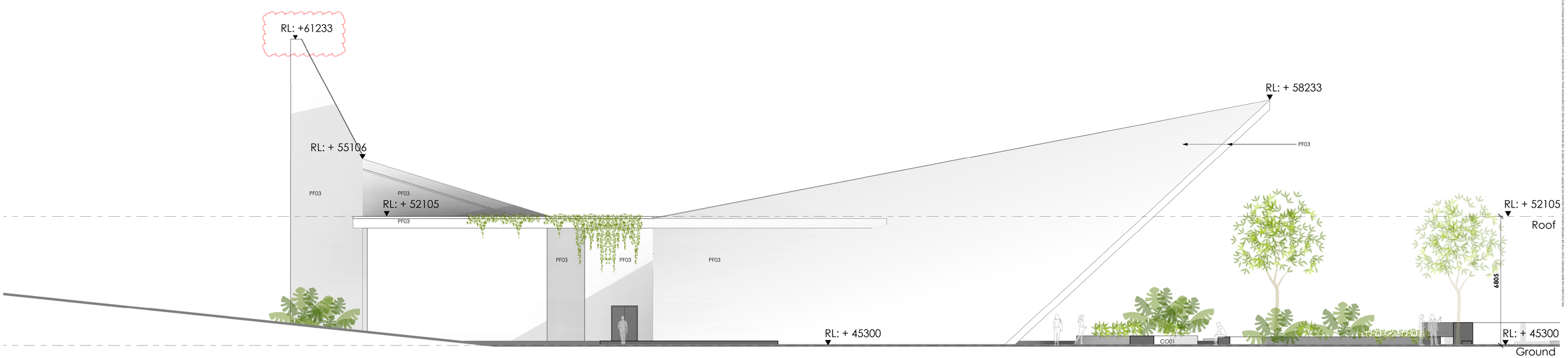
Drawing Scale @ A1: AS NOTED

Drawing Number:
DA-D4.03
Revision: B (MAY 2021)



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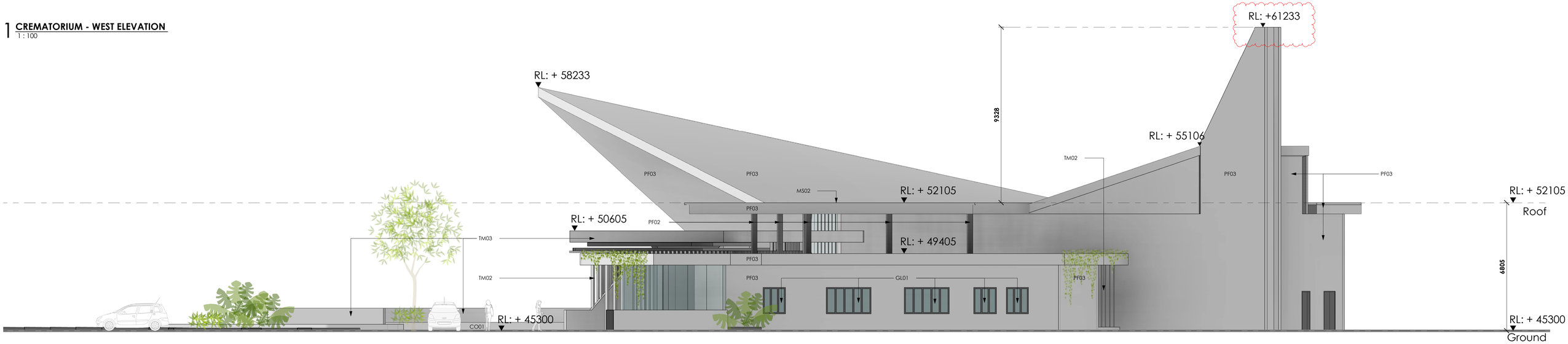

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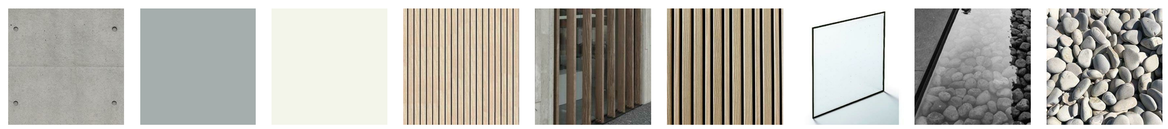

CO01
OFF-FORM CONCRETE

PF02
DULUX ALPHATEC BRIGHT SILVER - METALLIC POWDERCOATED PAINT FINISH

PF03
DULUX ALPHATEC WHITE - MATT PAINT FINISH

TM01
TIMBER DECK FINISH

TM02
TIMBER FINS

TM03
TIMBER CLADDING

GL01
CLEAR TOUGHENED GLASS

MS01
WATER FEATURE

MS02
PEBBLES

mkd architects
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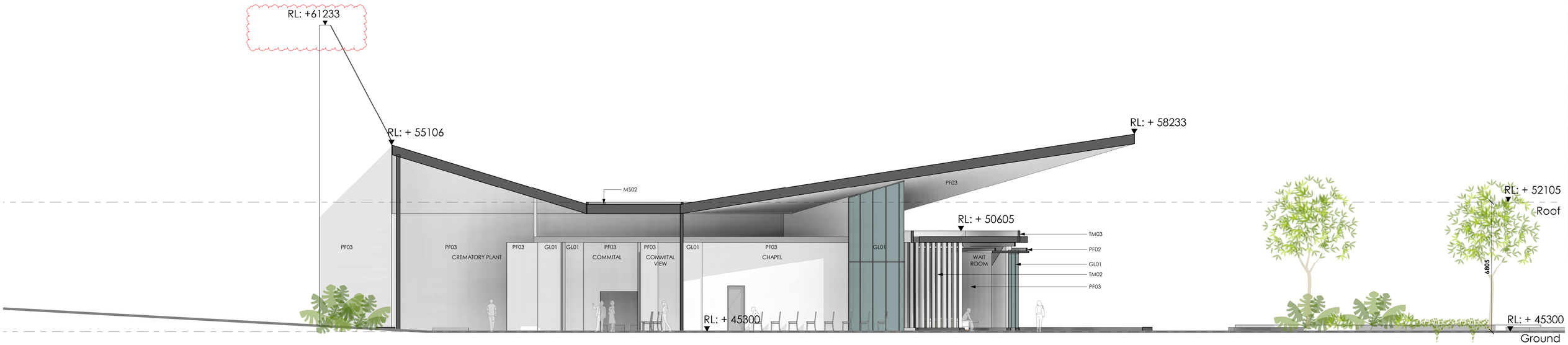
0 1 2 3 4 5

Project Address:
1290 GREENDALE PARK ROAD / WALLACIA
Client:
SOUKUTSU PTY LTD
Project Number:
20971
Project Status:
DA

Drawing Name:
CREMATORIUM ELEVATIONS
Drawing Scale @ A1: AS NOTED

Drawing Number:
DA-D4.04
Revision: B (MAY 2021)



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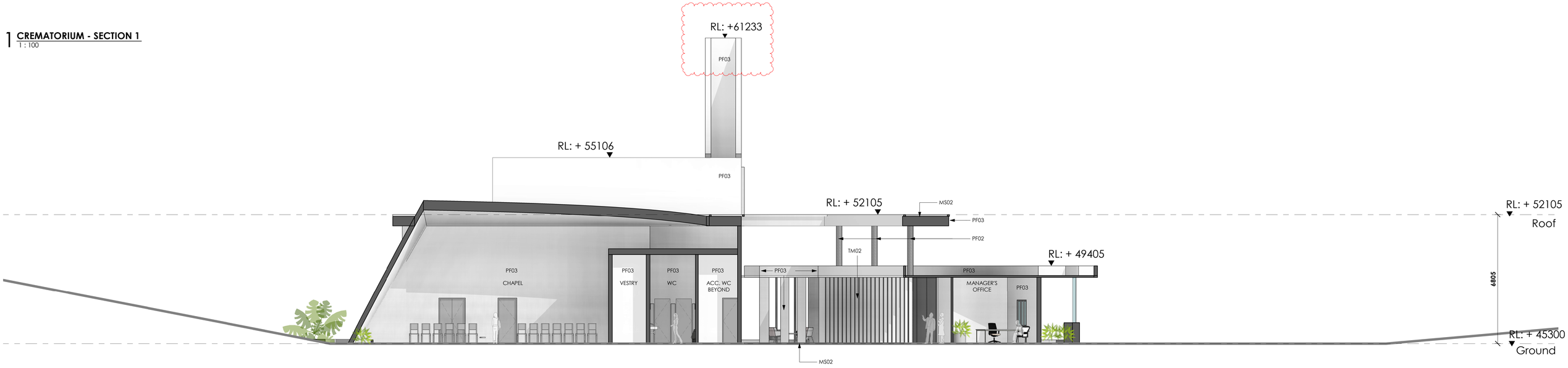

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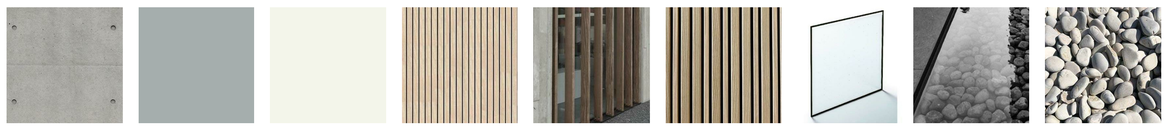

CO01
OFF-FORM CONCRETE

PF02
DULUX ALPHATEC BRIGHT SILVER - METALLIC POWDERCOATED PAINT FINISH

PF03
DULUX ALPHATEC WHITE - MATT PAINT FINISH

TM01
TIMBER DECK FINISH

TM02
TIMBER FINS

TM03
TIMBER CLADDING

GL01
CLEAR TOUGHENED GLASS

MS01
WATER FEATURE

MS02
PEBBLES

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0 1 2 3 4 5

Project Address:
1290 GREENDALE PARK ROAD / WALLACIA
Client:
SOUKUTSU PTY LTD
Project Number:
20971
Project Status:
DA

Drawing Name:
CREMATORIUM SECTIONS
Drawing Scale @ A1: AS NOTED
Drawing Number:
DA-D4.05
Revision: B (MAY 2021)

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Project Address:
1290 GREENDALE PARK ROAD / WALLACIA

Client:
SOUKUTSU PTY LTD

Project Number:
20971

Project Status:
DA

Drawing Name:
CREMATORIUM 3D VIEWS

Drawing Scale @ A1: NTS

Drawing Number:
DA-D4.06

Revision: A (NOV 2020)

GHD

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12517741-50463-39/https://projectsportal.ghd.com/sites/pp15_04/1290greedaleroad/ProjectDocs/12517741_REP_A_1290 Greendale Road Air Quality Assessment.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	E Smith	D Craggs		E Smith		29/04/21
0	E Smith	D Craggs		E Smith		05/05/21

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