REPORT
Blackmans Bay Wastewater Treatment Plant Odour Impact Assessment

Prepared for BMD Acciona JV
26/7/2016
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REVISION SCHEDULE

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<tr>
<th>Rev</th>
<th>Date</th>
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<tr>
<td>0</td>
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<td>Initial issue</td>
<td>GH</td>
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<td>IE/JB</td>
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<td>C</td>
<td>28/7/16</td>
<td>For issue to TasWater</td>
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BMD Acciona JV
Blackmans Bay WWTP Odour Impact Assessment

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1 Introduction

A significant augmentation is planned for the Blackmans Bay Wastewater Treatment Plant (WWTP) under TasWater’s Kingborough Sewerage Upgrade Project. MWH were engaged to investigate the potential odour impact from the new WWTP as part of the BMD Acciona Joint Venture (BAJV) tender design. A history of odour issues at the current site, coupled with regulatory compliance requirements, has been the basis for the odour impact assessment and the driver for key design features for the augmentation.

Odour impacts from the facility were previously modelled by Consulting Environmental Engineers in 2014 and summarised in the ‘Report on Odour Modelling for Blackmans Bay Wastewater Treatment Plant’, Consulting Environmental Engineers, April 2014 (CEE Odour Modelling Report, 2014).

The requirement for the augmentation of Blackmans Bay WWTP is to achieve no nuisance odours at nearby residences, together with meeting the odour criteria under EPA Tasmania’s Environment Protection Policy (Air Quality) 2004 (which requires an odour limit of 2 ou based on a 1 hour averaging period and 99.5% compliance, measured at or beyond the facility boundary).

MWH used data and information provided by TYR Group and TasWater to produce a CALPUFF odour dispersion model of the new site, including:

1. Meteorological modelling using hourly observational data from the Bureau of Meteorology’s four nearest meteorological stations (Dennes Point, Hobart, Kunyani and Grove) plus a single upper air station, Hobart Airport. Two models, the Australian CSIROs the Air Pollution Model (TAPM) and CALMET, the diagnostic meteorological component of the CALPUFF suite of models, were used to develop the meteorological data set at the WWTP; and

2. The latest available process and site layout information from the BAJV concept design.

The dispersion model inputs and results are summarised in this report, including an assessment of compliance against EPA Tasmania regulatory requirements.

2 Site Description

Blackmans Bay WWTP is located on the western shore of the lower Derwent estuary, on the headland south of the Blackmans Bay residential development and to the east of rural residences. A site location map is provided in Figure 2-1.

According to the Kingborough Council Planning Scheme 2000, the area containing the treatment plant and land immediately to the west is zoned primary industries. The strip of houses along Suncoast Drive and land further north is zoned residential. An area of recreational land use exists to the south of the facility, most likely used by the general public for exercise, bushwalking and by the local Scouts group.

The existing site boundary is shown as the red line in Figure 2-1 and the blue line represents what this report refers to as the ‘future site boundary’. The latest available information from TasWater suggests that approximately 7.3 ha of land surrounding and containing the existing WWTP may be purchased from Council by TasWater. Both the existing and potential future site boundaries are shown on the odour concentration contour plots in Section 5 and have been used in the assessment of odour compliance.
2.1 Odour Complaints

The existing site has historically been the source of odour complaints. The complaint data available (CEE Odour Modelling Report, 2014) has been combined with the provided Incident/Hazard management System (IHMS) Summary Report data and is presented in Table 2-1. It shows that the majority of the complaints arise from the houses to the north of the facility located on Suncoast drive, Liberty Crescent, and Tahune Crescent.

Figure 2-2 shows the location of the odour complaints (green dots) and those residences reporting odour in community odour logs (pink dots).
Table 2-1: Odour complaint history (IHMS)

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-Jan-16</td>
<td>99 Suncoast Drive, Blackmans Bay</td>
<td>Rang the call centre complaining about odour from the Blackmans Bay STP. The plant had a process change happen in the aeration tank between Christmas and New Year, the solids were not settling in the secondary clarifier. Ops increased the aeration and reduced the MLSS in the tank to try and rectify the problem. This action has overloaded the primary clarifier and some odour is noticeable around the perimeter of the plant. Also today the centrifuge brake system has broken down and Alpha electrics have been engaged to remove / repair, hopefully this work will be done by tomorrow and the centrifuge will be back up and running.</td>
</tr>
<tr>
<td>29-Jun-15</td>
<td>23 Tahune Crescent, Blackmans Bay</td>
<td>Odour complaint</td>
</tr>
<tr>
<td>10-Feb-15</td>
<td>11 Tahune Cres, Blackmans Bay</td>
<td>Odour complaint</td>
</tr>
<tr>
<td>22-Dec-14</td>
<td>99 Suncoast Drive, Blackmans Bay</td>
<td>Advised of strong sewage from the TP today. Inspected the treatment plant and a slight odour detected around the primary clarifier facility, the inline centrifuge is worn out overloading the primary clarifier with extra solids.</td>
</tr>
<tr>
<td>17-Nov-14</td>
<td>46 Suncoast Drive, Blackmans Bay</td>
<td>Odour complaint</td>
</tr>
<tr>
<td>5-Nov-14</td>
<td>71 Suncoast Drive, Blackmans Bay</td>
<td>Odour complaint</td>
</tr>
<tr>
<td>10-Oct-14</td>
<td>19 Tahune Cres, Blackmans Bay</td>
<td>Complaining of sewage odours today and over recent weeks. Has been very good over recent months but deteriorated over last week or so.</td>
</tr>
<tr>
<td>23-Jul-14</td>
<td>99 Suncoast Drive, Blackmans Bay</td>
<td>Described odour as really offensive and making her child dry reach. Winds light and conditions mild today. Inspected area and Blackmans Bay plant. No odour at residence by 9.45 am, although some odour noticeable around the plant. All systems functioning as normal.</td>
</tr>
</tbody>
</table>
### Date | Location | Notes
---|---|---
12-Feb-13 22 Tahune Cres Blackmans Bay | Odour complaint detailing ongoing odour issues over the weekend and also over the last 5-6 weeks. |
31-Jan-13 | Possible source of odour on Thursday we had a contractor doing some work on the centrifuge rollers (replacing rollers & realigning the belt) he needed access to the centrifuge room with his work van so he had to back up to the main roller door to do the work, so the door was open for about 5-6 hrs while he carried out his duties. This could have upset the drawing capacity of the odour fan and ducting system & possibly caused the odour as all other areas of the plant were working all right & we were not running the centrifuge that day. |
7-Jul-12 | | |
1-Oct-11 99 Suncoast Dr Blackmans Bay | I am writing to you to advise that there has been a terrible smell coming from the treatment plant over the weekend and today it was even worse. We went for a walk yesterday (Sunday) and you could smell the odour from the top of Suncoast Drive. |
31-May-10 | Odour complaint believed to come from Blackmans Bay treatment plant. Resident said that the odour has been on and off for about 10 months but was bad at the moment. |
10-Apr-10 Liberty Crt Blackmans Bay | Odour complaint regarding Blackmans Bay treatment plant. |

### 2.2 Process Summary

The existing treatment process at Blackmans Bay WWTP is currently operating at its design capacity of 4.2 ML/d (million litres per day). The facility uses a combination of treatment processes including screening, grit removal, primary sedimentation, biological secondary treatment and chlorine disinfection to achieve the required treatment. A site layout diagram is shown in Figure 2-3.

The inlet / screening area and biosolids handling equipment is housed in a building to the north east of the site, next to anaerobic digestion facilities. Foul air from the inlet works / screening and biosolids building is treated in a large open-bed type biofilter. Biogas is flared off in a waste gas burner located in the north east of the site.

The disinfected secondary effluent from the plant is discharged through a diffuser via an outfall extending to 14 m depth within the estuary. The diffuser produces a high dilution – generally in the range of 120:1 to 200:1 – and the effluent field is often submerged at 3 to 5 m below the surface waters on the interface between the saline and surface waters. A site layout of the existing facility is shown in the figure overleaf.

The plant is at capacity and will be significantly augmented. The new WWTP will increase capacity from 4.1 ML/day to 8.5 ML/day, improve effluent quality and ensure discharge into the Derwent Estuary complies with environmental regulations. The BAJV process design comprises an inlet works, suspended media secondary treatment process, sludge thickening, aerobic digestion, dewatering and storage prior to removal off-site. The latest available general arrangement drawing of the new WWTP (provided by TYR Group) is included in Appendix A.
2.3 Odour Emission Sources

A number of process units on-site were not included in the odour dispersion model since they are considered unlikely to generate odour emissions and cause environmental nuisance. These sources are listed in Table 2-2.

Table 2-2: Omitted process units in the Blackmans Bay WWTP dispersion model

<table>
<thead>
<tr>
<th>Process Unit</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine contact tanks (2No.)</td>
<td>The contents of the chorine contact tanks (chlorinated final effluent) are not known to emit an odour that causes offence. As such their inclusion would &quot;skew&quot; the model showing impact where there is none. They have therefore been excluded from the model.</td>
</tr>
<tr>
<td>Thickened sludge pump station</td>
<td>The thickened sludge pumping station is effectively just external pumps extracting from the gravity thickener. There is no liquid surface as such, other than that included for within the gravity thickener, thus no emission rate to surface in contact with the atmosphere.</td>
</tr>
<tr>
<td>Centrifuge and conveyors</td>
<td>Centrifuges, by definition, are sealed units. The odour from centrifuges is emitted from the centrate and sludge discharge lines. Both of these discharge lines will be sealed to the centrifuge and extracted from at a high rate as part of the augmentation works. After the augmentation works, the sludge at the point of dewatering (aerobically digested) will be of very</td>
</tr>
</tbody>
</table>

Figure 2-3: Existing Blackmans Bay WWTP site layout
Process Unit | Explanation
--- | ---
 | low odour potential, with the odour emission increasing as the sludge is stored post thickening (due to the action of shear and subsequent release of protein). As the sludge is of low odour potential at that point, and the discharge lines will be fully sealed with a high rate of extraction, this source has been excluded from the model.
 | Leakage from the dewatered cake self-loading bin, where anaerobic activity on the released protein will cause rapid production of odour driven by the release of reduced sulphur compounds, has been included in the model.

In order to obtain an indication of possible odour levels at Blackmans Bay WWTP, MWH have utilised the MWH Global Database to develop emission rates for inclusion in the dispersion model. The MWH Global Database contains over 8,000 odour sampling results taken from wastewater treatment plants in Australia, New Zealand, the Middle East and UK. The database is the largest of its kind worldwide, with emission rates categorised via equipment type, influent contaminant load and type, industrial loads, operation parameters, temperatures and geographical location. Data from only Australian WWTPs have been used in the modelling exercise.

Table 2-3 provides a summary of the specific odour emission rates (SOERs) and odour concentrations selected from the database for use in the model. Justification for the selected odour emission dataset is provided in the table. Scenario specific source tables are provided in Appendix B.

**Table 2-3: Odour emission rate derivation for the Blackmans Bay WWTP dispersion model**

<table>
<thead>
<tr>
<th>Odour Source</th>
<th>SOER (ou.m/s)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Works (screenings handling, grit classifier, bins)</td>
<td>4.47</td>
<td>Assumed to be a domestic network, dosed with Magnesium Hydroxide Liquid (MHL) to pH~8.5, relatively low temperature, and relatively aged sewage. Some potential industrial discharges (e.g. 'Tassal' fish processing, landfill leachate), but connection of these streams has not been agreed and they would be subject to pre-treatment prior to discharge to sewer. Thus, they have not been included within the estimate of the SOER. SOER based upon average of 10 odour samples taken from NSW sewage treatment facilities with similar inflows to the assumptions made.</td>
</tr>
<tr>
<td>Flow Distribution Channel</td>
<td>4.47</td>
<td></td>
</tr>
<tr>
<td>Inlet Works Return Pump Station</td>
<td>4.47</td>
<td>Assumed to be equal to the inlet works SOER for a conservative viewpoint</td>
</tr>
<tr>
<td>General Purpose Pump Station (centrate return)</td>
<td>4.47</td>
<td></td>
</tr>
<tr>
<td>Odour Source</td>
<td>SOER (ou.m/s)</td>
<td>Notes</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>---------------</td>
<td>-------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>IDEA-SBR 1 Anoxic Selector Zone</td>
<td>1.70</td>
<td>90%ile of 18 SOER data points taken from anoxic selector zones on NSW / NZ sites</td>
</tr>
<tr>
<td>IDEA-SBR 1 Secondary Anoxic Zone</td>
<td>0.695</td>
<td>Average of 18 SOER data points taken from anoxic zones on NSW / NZ sites</td>
</tr>
<tr>
<td>IDEA-SBR 1 Aeration Phase</td>
<td>0.313</td>
<td>90%ile of 14 SOER data points taken from IDEA / SBR zones during aerobic phase on NSW sites (&gt;20 day sludge age)</td>
</tr>
<tr>
<td>IDEA-SBR 1 Anoxic Phase</td>
<td>0.695</td>
<td>Assumed to be equal to the secondary anoxic zone emission (conservative)</td>
</tr>
<tr>
<td>IDEA-SBR 1 Settling / Decant Phase</td>
<td>0.076</td>
<td>Average of 18 SOER data points taken from equivalent decant phases on NSW / QLD sites</td>
</tr>
<tr>
<td>IDEA-SBR 2 Anoxic Selector Zone</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>IDEA-SBR 2 Secondary Anoxic Zone</td>
<td>0.695</td>
<td></td>
</tr>
<tr>
<td>IDEA-SBR 1 Aeration Phase</td>
<td>0.313</td>
<td>As per IDEA-SBR 1</td>
</tr>
<tr>
<td>IDEA-SBR 1 Anoxic Phase</td>
<td>0.695</td>
<td></td>
</tr>
<tr>
<td>IDEA-SBR 1 Settling / Decant Phase</td>
<td>0.076</td>
<td></td>
</tr>
<tr>
<td>Gravity Thickener</td>
<td>0.20</td>
<td>90%ile of 10 SOER samples for open gravity thickener for WAS. Assumed sludge is not stored in the gravity thickener tank.</td>
</tr>
<tr>
<td>Aerobic Digester - Aerobic Cells</td>
<td>0.15</td>
<td>Average emission from aerobic digester during aeration phase (6 samples from QLD sites for conservative view)</td>
</tr>
<tr>
<td>Aerobic Digester - Anoxic Cells</td>
<td>0.30</td>
<td>Peak emission from aerobic digester during anoxic phase (6 samples from QLD sites for conservative view)</td>
</tr>
<tr>
<td>Dewatered Cake Self-Loading Bin</td>
<td>29.38</td>
<td>Conservative view, SOER of anaerobically digested dewatered sludge, aged for 12 hours after dewatering in an enclosed bin. Anticipated that aerobically digested sludge will be of a lower magnitude.</td>
</tr>
<tr>
<td>Odour Control Facility Stack</td>
<td>n/a</td>
<td>500 ou discharge concentration (biotrickling filter / activated carbon two stage)</td>
</tr>
</tbody>
</table>

### 2.4 Odour Constituents by Plant Area

The expected constituents of the gas streams that make up the odour are detailed below. The concentrations of each constituent will generate seasonal daily and hourly cyclic variances due to changes in sewage composition, or storage time of products.
2.4.1 Preliminary Treatment

The main odour constituents are;

**Hydrogen sulphide gas (odour threshold 0.008ppm, rotten egg odour):** generated within the sewerage network by anaerobic conditions and resulting sulphate respiration. The concentration of gas will vary seasonally due to eth variance in temperature, and daily due to wastewater flow changes. Increasing temperature and decreasing wastewater flow will produce elevated concentrations. Generally will be at concentrations (under covers) anywhere from 10 to 50ppm.

**Methyl mercaptan (odour threshold 0.14-0.18ppb, decayed cabbage / garlic odour):** generated via anaerobic breakdown of protein in wastewater. Generally will be at concentrations of 0.5 to 1 ppm under odour containment covers.

**Dimethyl sulphide (odour threshold 012-0.4ppb, decayed vegetables / Putrefaction):** again generated via anaerobic breakdown of protein in wastewater. Generally will be at concentrations of 0.5 to 1 ppm under odour containment covers.

**Ammonia (odour threshold 130ppb, sharp pungent odour):** generally associated with digested sludge returns. Generally will be at concentrations of 1 to 5 ppm under odour containment covers, reducing when anaerobic digestion is ceased.

**Volatile Organic Compounds – VOCs (Odour threshold from 1ppb to 100’s ppm and varying odour type depending upon species).** From household waste and industrial discharges (such as landfill leachate). Compounds vary significantly depending upon discharge, but generally include aromatic hydrocarbons, aldehydes, ketones, and alcohols. Chlorinated hydrocarbons are also usually present.

2.4.2 Secondary Treatment

The main odour constituents are;

**Hydrogen sulphide gas (odour threshold 0.008ppm, rotten egg odour):** Generally below 0.1ppm due to rapid oxidation in aerobic zone.

**Methyl mercaptan (odour threshold 0.14-0.18ppb, decayed cabbage / garlic odour):** Generally not detected due to rapid oxidation

**Dimethyl Sulphide (odour threshold 012-0.4ppb, decayed vegetables / Putrefaction):** Generally not detected due to rapid oxidation

**Ammonia (odour threshold 130ppb, sharp pungent odour):** Generally not detected due to rapid oxidation and high odour threshold

**Volatile Organic Compounds – VOCs (Odour threshold from 1ppb to 100’s ppm and varying odour type depending upon species).** From household waste and industrial discharges (such as landfill leachate). Compounds vary significantly depending upon discharge, but generally include aromatic hydrocarbons, aldehydes, ketones, and alcohols. Chlorinated hydrocarbons are also usually present.

2.4.3 Sludge Area

The aerobic digester should not produce / cause emission of significant odorous compounds. VOCs are emitted, together with very low concentrations of sulphur compounds – however this source is not related to odour complaints.

The main odour constituents are generated in the dewatering and storage of sludge. Dewatering sludge applies shear forces to the floc which releases protein. The greater the shear force applied, the more protein is released. This protein is then converted to odorous compounds via anaerobic activity during storage as per the cycle below.
Figure 2-4: Compounds produced via sludge storage after dewatering

**Hydrogen sulphide gas (odour threshold 0.008ppm, rotten egg odour):** Concentration in storage generally in the 1 to 10ppm range depending upon storage duration.

**Methyl mercaptan (odour threshold 0.14-0.18ppb, decayed cabbage / garlic odour):** Concentration in storage generally in the 5 to 20ppm range depending upon storage duration.

**Dimethyl Sulphide (odour threshold 0.12-0.4ppb, decayed vegetables / Putrefaction):** Concentration in storage generally in the 1 to 10ppm range depending upon storage duration.

**Ammonia (odour threshold 130ppb, sharp pungent odour):** Generally not seen in aerobically digested sludge.

**Volatile Organic Compounds – VOCs (Odour threshold from 1ppb to 100’s ppm and varying odour type depending upon species):** Generally in the 1 to 5ppm range.
3 Modelling Methodology

3.1 Modelling Approach

The atmospheric dispersion modelling assessment has been undertaken using CALPUFF (version 7.2.1, level 150618). It was considered that the CALPUFF model would represent the dispersion of odour at the project site better than a Gaussian plume dispersion model such as AERMOD or AUSPLUME.

CALPUFF has been used extensively in Australia and New Zealand and is a recommended model in the New South Wales Office of Environment and Heritage’s (NSW OEH) Approved Methods (OEH, 2005)\(^1\), particularly for sites surrounded by complex terrain and where light or low wind speed conditions are likely to occur. CALPUFF is a non-steady state Lagrangian Gaussian puff model containing modules for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. In other words, the model can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation and removal.

The modelling was set up and performed in accordance with EPA Tasmania’s current Draft of Tasmanian Atmospheric Dispersion Modelling Guidelines V 0.93e (Draft) Last modified 29 January 2016 and the guidance contained the NSW OEH’s Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the ‘Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia’ dated March 2011\(^2\).

3.2 Meteorological Data and Model Run Period

Meteorological modelling for a full year period in 2015 has been conducted for Blackmans Bay WWTP. The year 2015 of meteorological data was chosen as it represents a recent year in a neutral El Nino year. The meteorological data set has been custom built to the Blackmans Bay site. The meteorological model has used hourly observational data from the Bureau of Meteorology’s four nearest meteorological stations which are Dennes Point, Hobart, Kunyani and Grove plus a single upper air station, Hobart Airport. Two models, the Australian CSIROs the Air Pollution Model (TAPM) and CALMET, the diagnostic meteorological component of the CALPUFF suite of models, were used to develop the meteorological data set at the WWTP. Both models are recognised as guideline models in Australia and New Zealand. Hourly observational data of temperature, wind speed, direction, relative humidity and pressure were obtained from all four of the meteorological stations.

As well as preparing a one year meteorological data set, an analysis has been conducted on two historic data sets that have been used in previous air modelling. The first is a December 2004 - December 2005 AUSPLUME prepared meteorological data set from monitored data at Blackmans Bay. The second is an AUSPLUME data set derived from TAPM data for 2006 which was used in odour modelling in 2014 (summarised in the CEE Odour Modelling Report, 2014). An evaluation of the monitored on-site data for 2005 suggests that the wind direction has been incorrectly reported in the AUSPLUME meteorological file and is 180 degrees out. This error was not picked up in the 2014 modelling and Blackmans Bay data was ruled as ‘unsuitable’ as the anemometer is located on a building and does not meet the Australian Wind monitoring standards. However, when the wind direction data is corrected the data appears good and acceptable for use in modelling. The second data set, the 2006 AUSPLUME data set developed from TAPM data at the Blackmans Bay site was used in the 2014 modelling. An in-depth analysis showed that the TAPM derived westerly flow dominated the daily cycle, even during the day when onshore sea breezes are common daily occurrence especially in summer.

\(^1\) Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, Department of Environment and Conservation NSW (DEC), NSW Environment Protection Authority (EPA), August, 2005 (the ‘Approved Methods’).

The new 2015 data set has been exclusively developed from observation stations and Hobart Upper Air Data as TAPM either as gridded 3-dimensional data or individual profiles did not perform well. However, because Dennes Point is the closest location to the WWTP there is a tendency for the wind patterns to be similar to Dennes Point. This is a reasonable assumption given their close location.

Development of a meteorological data set at Blackmans Bay WWTP is highly complex due to the large scale topographic features upwind, the effects of the Peninsula, the sea breeze and the local topography around the facility. It is highly recommended to reinstall a meteorological station at Blackmans Bay WWTP. Further, it is recommended that the 2005 on-site AUSPLUME meteorological data be corrected and then used directly in CALPUFF to provide robustness to the 2015 modelling.

A full report and detailed assessment is provided in Appendix C.

### 3.3 Dispersion Options

The NSW OEH’s generic guidance document on CALPUFF recommends that the model should be run using the turbulence-based dispersion coefficients rather than the US EPA default method, which uses the Pasquill-Gifford (PG) curves and ISC rural dispersion coefficients and McElroy-Pooler (MP) curves for urban dispersion coefficients (collectively known as the ‘PG/MP dispersion coefficients’).

In this assessment, MWH selected the turbulence-based dispersion coefficients option in CALPUFF, in accordance with OEH (2011) and the Approved Methods (OEH, 2005). Heights and dimensions of nearby buildings as input in the US EPA building wake program, BPIP, to account for the effect that building downwash has on plume dispersion from point source emissions. Buildings/structures included were the control building, centrifuge/sludge handling building, MCC/blower building, biotrickling filter and activated carbon vessels, and the existing anaerobic digester.

### 3.4 Terrain Elevations

The CALMET and CALPUFF models include terrain data sourced from the SRTM-3 digital elevation model (90 m resolution) data originally produced by NASA. The gridded data is representative of the local terrain within the modelling domain, and assists in simulating the effects of land surface elevations on plume dispersion and hence odour dispersion.

Figure 3-1 shows the area surrounding the project site, including the terrain input into CALPUFF and the discrete receptor layout (indicated with red crosses). Three sets of discrete receptor grids were used, varying from a coarse to a fine resolution. The 10 km x 10 km outer receptor grid has a resolution of 500 m, the second inner grid of 5 km x 5 km has a resolution of 250 m, and the innermost grid of receptors centred 2 km around the WWTP has a resolution of 100 m. A total of 1200 receptors were used.

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4 Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, Department of Environment and Conservation NSW (DEC), NSW Environment Protection Authority (EPA), August, 2005 (the ‘Approved Methods’).
3.5 Sensitive Receptors

In the context of this odour assessment, the term ‘sensitive receptor’ includes any persons, locations or systems that may be susceptible to changes in ambient odour concentrations as a consequence of discharges to air (i.e. odour) from the project site.

Typical locations for sensitive receptors include:

- Residential properties;
- Retirement villages;
- Hospitals or medical centres;
- Schools;
- Libraries; and,
- Public outdoor locations (e.g. parks, reserves, sports fields).

Table 3-1 presents a summary of the discrete receptors representing potential odour-sensitive locations surrounding Blackmans Bay WWTP, also shown in Figure 3-2.
### Table 3-1: Sensitive receptor locations used in the modelling

<table>
<thead>
<tr>
<th>Receptor ID</th>
<th>Description</th>
<th>Easting MGA X (km)</th>
<th>Northing MGA Y (km)</th>
<th>Elevation (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rural property to the west of WWTP (within land identified to be purchased by TasWater)</td>
<td>526.587</td>
<td>5237.410</td>
<td>58.6</td>
</tr>
<tr>
<td>2</td>
<td>Rural property to the west of WWTP</td>
<td>526.446</td>
<td>5237.377</td>
<td>71.7</td>
</tr>
<tr>
<td>3</td>
<td>Rural property to the west of WWTP (nearest to the Scout hall)</td>
<td>526.407</td>
<td>5237.328</td>
<td>69.3</td>
</tr>
<tr>
<td>4</td>
<td>Residential property along Suncoast Drive, to the north of WWTP</td>
<td>526.598</td>
<td>5237.581</td>
<td>65.9</td>
</tr>
<tr>
<td>5</td>
<td>Residential property along Suncoast Drive, to the north of WWTP</td>
<td>526.677</td>
<td>5237.631</td>
<td>60.2</td>
</tr>
<tr>
<td>6</td>
<td>Residential property along Suncoast Drive, to the north of WWTP</td>
<td>526.779</td>
<td>5237.651</td>
<td>46.8</td>
</tr>
<tr>
<td>7</td>
<td>Rural property to the south west of WWTP</td>
<td>526.382</td>
<td>5236.966</td>
<td>98.0</td>
</tr>
</tbody>
</table>

**Figure 3-2:** Aerial base map showing the project site and sensitive receptor locations

- Current TasWater land
- TasWater will purchase land from Council
4 Odour Assessment Criteria

The Environment Protection Authority for Tasmania (EPA Tasmania) is the state’s independent environmental regulator and was established under the Environmental Management and Pollution Control Act 1994 (‘the Act’ or EMPCA). Under the powers of the Act, EPA Tasmania is responsible for protecting the environment and the community through effective regulation of industry and pollution, including odour discharges.

Impacts from odorous air contaminants are often nuisance-related rather than health-related. Odour performance goals guide decisions on odour management, but are generally not intended to achieve “no odour”. The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit (ou). An odour goal of less than 1 ou would theoretically result in no odour impact being experienced.

In practice, the character of a particular odour can only be judged by the receiver’s reaction to it, and preferably only compared to another odour under similar social and regional conditions. Based on the literature available, the level at which an odour is perceived to be a nuisance can range significantly depending on a combination of the following factors:

- **Odour quality**: whether an odour results from a pure compound or from a mixture of compounds. Pure compounds tend to have a higher threshold (lower offensiveness) than a mixture of compounds.
- **Population sensitivity**: any given population contains individuals with a range of sensitivities to odour. The larger a population, the greater the number of sensitive individuals it may contain.
- **Background level**: whether a given odour source, because of its location, is likely to contribute to a cumulative odour impact. In areas with more closely-located sources it may be necessary to apply a lower threshold to prevent offensive odour.
- **Public expectation**: whether a given community is tolerant of a particular type of odour and does not find it offensive, even at relatively high concentrations. For example, background agricultural odours may not be considered offensive until a higher threshold is reached than for odours from a landfill facility.
- **Source characteristics**: whether the odour is emitted from a stack (point source) or from an area (diffuse source). Generally, the components of point source emissions can be identified and treated more easily than diffuse sources. Emissions from point sources can be more easily controlled using control equipment. Point sources tend to be located in urban areas, while diffuse sources are more often located in rural locations.
- **Health Effects**: whether a particular odour is likely to be associated with adverse health effects. In general, odours from agricultural activities are less likely to present a health risk than emissions from industrial facilities.

Experience gained through odour assessments from proposed and existing odour-generating facilities in Tasmania (including wastewater treatment plants) indicates that an odour performance goal of 2 ou is likely to represent the level below which an “offensive” odour should not occur (for an individual with a ‘standard sensitivity’ to odour).

In Schedule 3 of Environment Protection Policy (Air Quality) 2004 (‘the EPP’), the EPA Tasmania has recommended an odour threshold concentration (design criterion) of 2 ou, and no members of the public should be exposed to ambient odour concentrations above this criterion value. This criterion value is expressed as the 99.5% percentile and as a 1-hour mean concentration in effect at the site boundary. We have assumed this to mean the land within the restrictive easement area.

It is expected that an odour impact assessment criterion of 2 ou (expressed as the 99.5% percentile for a 1-hour mean concentration) would appropriately assess the odour performance of the project site.
5 Odour Impact Assessment

Four scenarios were modelled to predict the odour impact of the new Blackmans Bay WWTP and one additional scenario was evaluated:

- Scenario 1: Normal Operation of the New WWTP
- Scenario 2: Inlet Works Maintenance Period for the New WWTP
- Scenario 3: Upset in the Treatment Process for the New WWTP
- Scenario 4: Upset in the Sludge Processing for the New WWTP
- Scenario 5: Commissioning Activities with the New WWTP

5.1 Scenario 1 – Normal Operation of the New WWTP

Odour emissions from the new Blackmans Bay WWTP were modelled in CALPUFF to assess the predicted odour impact under normal operations.

5.1.1 Odour Emission Data and Assumptions

Odour emissions from the new Blackmans Bay WWTP were modelled in CALPUFF to assess the predicted odour impact under normal operations. The Scenario 1 odour emission sources are listed in Table B-1 in Appendix B, with covered / ventilated sources highlighted in blue. The odour sources presented are based on the following assumptions:

- Odour source locations were based on the BAJV general arrangement site plan ‘G002-AA008274-P7’ provided by TYR Group and included in Appendix A. Surface areas for area sources were provided by TYR Group;
- SOERs and odour concentrations were selected using the MWH odour emission database (refer Table 2-3). A constant emission rate was assumed for each odour source for the duration of the year, apart from the IDEA-SBR Aeration, Anoxic and Settling/Decant phases which assumed the following:
  - An operating schedule comprising a 30 minute Anoxic phase, 1 hour 30 minutes Aerobic phase, and 2 hour Settling/Decant phase (provided by TYR Group). Due to the hourly-averaged model time-step, this was input in CALPUFF as 3 cycles of a 1 hour Anoxic; 3 hours Aerobic; and 4 hours Settling/Decant cycle across a 24 hour period.
  - Time-variable scaling factors were applied to the SOERs for Aerobic/Anoxic/Settling phases listed in Table 5-4 and summary Table B-1.
- The following process areas were modelled as covered, with forced extraction of foul air to the Biotrickling Filter Odour Control Facility (OCF):
  - Inlet Works incl. the screenings handling, grit classifier and bins (95% cover capture)
  - Flow Distribution Channel (99% cover capture)
  - Inlet Works Return Pump Station (99% cover capture)
  - Centrifuge and sludge transfer conveyors (not included in the model)
  - Dewatered Cake Self-Loading Bin (99.9% capture)
- The OCF is a two stage biotrickling filter / activated carbon system, modelled with an OER of 901 ou.m\(^3\)/s and based on the following assumptions:
  - an odour discharge concentration of 500 ou, equivalent to a two stage biotrickling filter with downstream activated carbon polishing
  - an air flow of 6,586 m\(^3\)/hr, based on air changes specified in the BAJV Basis of Design and extraction rates for covered process areas listed above
  - a stack diameter of 0.391 m to achieve a 15 m/s exit velocity with the air flow above
  - a stack height of 12 m to provide sufficient dispersion
Odour emissions from the chlorine contact tanks, thickened sludge pump station and centrifuges were not included in the model.

The following tables detail the location and source parameters of all modelled point and area sources input in Scenario 1. A summary source input table for Scenario 1 can be found in Appendix B, along with source information for Scenarios 2-4.

The location of the point emission source at the Blackmans Bay WWTP is provided in Table 5-1 and shown in Figure 5-1.

**Table 5-1: Point emission source locations**

<table>
<thead>
<tr>
<th>Source ID</th>
<th>Source Description</th>
<th>Easting (km)</th>
<th>Northing (km)</th>
<th>Elevation (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTFOCF</td>
<td>Biotrckling Filter Odour Control Facility Stack</td>
<td>526.717</td>
<td>237.364</td>
<td>35.8</td>
</tr>
</tbody>
</table>

The odour emission rate in ou.m³/s for the wake-affected stack in Scenario 1 is provided in Table 5-2. The odour emission was assumed to be constant (i.e. 24 hours a day, 7 days a week) throughout the 1-year model run period.

**Table 5-2: Odour emission data input into the model for point sources**

<table>
<thead>
<tr>
<th>Source ID</th>
<th>Source Description</th>
<th>Stack Height (m)</th>
<th>Stack Diameter (m)</th>
<th>Stack Temperature (K)</th>
<th>Exit Velocity (m/s)</th>
<th>OER (ou.m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTFOCF</td>
<td>Biotrckling Filter Odour Control Facility Stack</td>
<td>12</td>
<td>0.391</td>
<td>298</td>
<td>15</td>
<td>901</td>
</tr>
</tbody>
</table>

The location of the 18 area emission sources which were input into the model are provided in Table 5-3.

**Table 5-3: Area emission source locations**

<table>
<thead>
<tr>
<th>Source ID</th>
<th>Source Description</th>
<th>Easting (km)</th>
<th>Northing (km)</th>
<th>Elevation (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INWRKS</td>
<td>Inlet Works (screenings handling, grit classifier, bins)</td>
<td>526.648</td>
<td>5237.356</td>
<td>48.5</td>
</tr>
<tr>
<td>FLWDST</td>
<td>Flow Distribution Channel</td>
<td>526.683</td>
<td>5237.363</td>
<td>44.6</td>
</tr>
<tr>
<td>IWPUMP</td>
<td>Inlet Works Return Pump Station</td>
<td>526.643</td>
<td>5237.357</td>
<td>49.8</td>
</tr>
<tr>
<td>GPPUMP</td>
<td>General Purpose Pump Station (centrate return)</td>
<td>526.746</td>
<td>5237.425</td>
<td>32.7</td>
</tr>
<tr>
<td>1ANOX1</td>
<td>IDEA-SBR 1 Anoxic Selector Zone</td>
<td>526.685</td>
<td>5237.368</td>
<td>43.0</td>
</tr>
<tr>
<td>1ANOX2</td>
<td>IDEA-SBR 1 Secondary Anoxic Zone</td>
<td>526.666</td>
<td>5237.370</td>
<td>43.0</td>
</tr>
<tr>
<td>1AERAT</td>
<td>IDEA-SBR 1 Aeration Phase</td>
<td>526.666</td>
<td>5237.382</td>
<td>43.0</td>
</tr>
<tr>
<td>1ANOX3</td>
<td>IDEA-SBR 1 Anoxic Phase</td>
<td>526.666</td>
<td>5237.382</td>
<td>43.0</td>
</tr>
</tbody>
</table>
The specific odour emission rates (ou.m/s) for the area sources input in Scenario 1 are provided in Table 5-4. The odour emissions were assumed to be constant (i.e. 24 hours a day, 7 days a week) throughout the run period, apart from the IDEA-SBR Aeration, Anoxic and Settling/Decant phases (described above).

### Table 5-4: Odour emission data input into the model for area sources

<table>
<thead>
<tr>
<th>Source ID</th>
<th>Source Description</th>
<th>Source Area (m²)</th>
<th>Release Height (m)</th>
<th>Initial Sigma z (m)</th>
<th>SOER (ou.m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INWRKS</td>
<td>Inlet Works (screenings handling, grit classifier, bins)</td>
<td>72</td>
<td>1.9</td>
<td>1</td>
<td>0.224</td>
</tr>
<tr>
<td>FLWDST</td>
<td>Flow Distribution Channel</td>
<td>24</td>
<td>2.9</td>
<td>1</td>
<td>0.045</td>
</tr>
<tr>
<td>IWPUMP</td>
<td>Inlet Works Return Pump Station</td>
<td>4</td>
<td>0.0</td>
<td>1</td>
<td>0.045</td>
</tr>
<tr>
<td>GPPUMP</td>
<td>General Purpose Pump Station (centrate return)</td>
<td>7</td>
<td>0.0</td>
<td>1</td>
<td>4.470</td>
</tr>
<tr>
<td>1ANOX1</td>
<td>IDEA-SBR 1 Anoxic Selector Zone</td>
<td>58</td>
<td>2.4</td>
<td>1</td>
<td>1.700</td>
</tr>
<tr>
<td>1ANOX2</td>
<td>IDEA-SBR 1 Secondary Anoxic Zone</td>
<td>192</td>
<td>2.4</td>
<td>1</td>
<td>0.695</td>
</tr>
<tr>
<td>1AERAT</td>
<td>IDEA-SBR 1 Aeration Phase</td>
<td></td>
<td>2.4</td>
<td>1</td>
<td>0.313</td>
</tr>
<tr>
<td>1ANOX3</td>
<td>IDEA-SBR 1 Anoxic Phase</td>
<td>1,062</td>
<td>2.4</td>
<td>1</td>
<td>0.695</td>
</tr>
<tr>
<td>1DECAN</td>
<td>IDEA-SBR 1 Settling / Decant Phase</td>
<td></td>
<td>2.4</td>
<td>1</td>
<td>0.076</td>
</tr>
<tr>
<td>2ANOX1</td>
<td>IDEA-SBR 2 Anoxic Selector Zone</td>
<td>58</td>
<td>2.4</td>
<td>1</td>
<td>1.700</td>
</tr>
<tr>
<td>2ANOX2</td>
<td>IDEA-SBR 2 Secondary Anoxic Zone</td>
<td>192</td>
<td>2.4</td>
<td>1</td>
<td>0.695</td>
</tr>
</tbody>
</table>
The location of the Scenario 1 emission sources and buildings is shown in Figure 5-1, using the source ID referred to in Table 5-1 and Table 5-3. The existing (red line) and future (blue line) site boundaries are also shown.

5.1.2 Modelling Results

Figure 5-2 presents a dispersion plot of the predicted odour impact of the new Blackmans Bay WWTP under normal operation (Scenario 1). The white contour line indicates the EPA Tasmania 2 ou, 99.5th percentile assessment criteria for Scenario 1.

The model predicts that the odour impact of the new WWTP does not exceed the 2 ou, 99.5th percentile criteria at or beyond the future site boundary indicated in the plot (a combination of current
TasWater land and land which may be purchased from Council). Based on the model inputs and assumptions listed in this report, and assuming the site boundary is extended to the west and south of the existing WWTP as indicated in the figure, Scenario 1 complies with the EPA Tasmania odour criteria.

5.2 Scenario 2 – Inlet Works Maintenance Period for the New WWTP

Odour emissions from the new Blackmans Bay WWTP were modelled in CALPUFF to assess the predicted odour impact during scheduled maintenance at the inlet works.

5.3 Odour Emission Data and Assumptions

The Scenario 2 odour emission sources are listed in Table C-2 in Appendix B with covered / ventilated sources highlighted in blue. The odour sources presented are the same as those presented for Scenario 1 with the exception of the following:
- An increase in odour emissions from the inlet works by 100% to represent a period of scheduled maintenance at the inlet works i.e. the SOER was doubled for the inlet works, flow distribution channel, inlet works return pump station and general purpose pump station.

### 5.3.1 Modelling Results

Figure 5-3 presents a dispersion plot of the predicted odour impact of the new Blackmans Bay WWTP under inlet works maintenance conditions (Scenario 2). The yellow contour line indicates the EPA Tasmania 2 ou, 99.5\(^{th}\) percentile assessment criteria for Scenario 2. The Scenario 1 white contour is also shown for reference.

Such an increase in emission rates would result in the removal of a proportion of covers, resulting in loss of negative pressure and thus containment. Even so, the resulting footprint is not significantly different to the base case.

If total cover removal was required (to respond to a major maintenance or failure issue), which would increase emissions further, the emissions could be mitigated by increasing the magnesium hydroxide chemical dose into the network, raising the incoming pH to 8.8 to 9.

The model predicts that the odour impact of the new WWTP under inlet works maintenance conditions does not exceed the 2 ou, 99.5\(^{th}\) percentile criteria at or beyond the future site boundary indicated in the plot (a combination of current TasWater land and land to be purchased from Council). Based on the model inputs and assumptions listed in this report, and assuming the site boundary is extended to the west and south of the existing WWTP as indicated in the figure, Scenario 2 complies with the EPA Tasmania odour criteria.
5.4 Scenario 3 – Upset in the Treatment Process for the New WWTP

Odour emissions from the new Blackmans Bay WWTP were modelled in CALPUFF to assess the predicted odour impact under treatment process upset conditions.

5.4.1 Odour Emission Data and Assumptions

The Scenario 3 odour emission sources are listed in Table B-3 in Appendix B, with covered / ventilated sources highlighted in blue. The odour sources presented are the same as those presented for Scenario 1 with the exception of the following:

- An increase in odour emissions from all process tanks by 100% to represent treatment process upset conditions i.e. the SOER was doubled for the inlet works, flow distribution channel, inlet...
works return pump station, general purpose pump station, secondary treatment IDEA-SBR
tanks, gravity thickener, and aerobic digester.

5.5 Modelling Results

Figure 5-4 presents a dispersion plot of the predicted odour impact of the new Blackmans Bay
WWTP under treatment process upset conditions (Scenario 3). The red contour line indicates the
EPA Tasmania 2 ou, 99.5th percentile assessment criteria for Scenario 3. The Scenario 1 white
contour is also shown for reference.

The model predicts that the odour impact of the new WWTP under treatment process upset
conditions exceeds the 2 ou, 99.5th percentile criteria at the existing site boundary (red dotted line)
and the extended, future boundary (blue dotted line) as a result of TasWater’s purchase of land from
Council.

Scenario 3 does not comply with the EPA Tasmania odour criteria, however it is not considered to
be a realistic failure mode of the facility, and is highly unlikely to occur. It should be considered to
be an “absolute worst possible” scenario. The following should be noted;

1. Issues in sewage processing which effect odour emissions across the entire treatment
process from the inlet works to the secondary treatment process are generally limited to an
unauthorised industrial type discharge of an organic low volatility material. Such a discharge
cannot be predicted, and in any case, would generally only be of significant magnitude to
effect part of the process rather than all process units at the same time.

2. It should be noted that this scenario has been modelled as if a process upset impacting the
process units listed above occurs throughout the entire year (with the impact shown being the
99.5 percentile impact). This is not a realistic occurrence. Such a catastrophic process
upset would only occur for a short period (hours or days) which is not reflected in this model
output. The process upset would have to occur consistently during times of poor
meteorological impact and at times when sensitive populations are within the small impacted
area for an odour complaint to occur, which is considered a highly unlikely event.

3. The only liquid stream impacts which have a possibility of occurring are;

   a. A “washout” resulting in reduced sludge age. Reducing the sludge age by 5 days
      would increase the aeration phase emissions by approximately 20% to 25%, which
      would not exceed the EPA criteria

   b. Failure of one or more of the aeration grids resulting in anoxic conditions in part of
      the SBR during aeration. This would result in a doubling of the emission for that part
      of the cell for the duration of the aeration phase. This would not exceed the EPA
      criteria.
5.6 Scenario 4 – Upset in the Sludge Processing for the New WWTP

Odour emissions from the new Blackmans Bay WWTP were modelled in CALPUFF to assess the predicted odour impact under sludge processing upset conditions.

5.6.1 Odour Emission Data and Assumptions

The Scenario 4 odour emission sources are listed in Table B-4 in Appendix B, with covered / ventilated sources highlighted in blue. The odour sources presented are the same as those presented for Scenario 1 with the exception of the following:

- An increase in odour emissions from areas surrounding the centrifuge building by 100% to represent sludge processing upset conditions i.e. the SOER was doubled for the dewatered
cake self-loading bin. Note that emissions from the centrifuges building were not included in the model (refer Table 2-2).

5.6.2 Modelling Results

Figure 5-5 presents a dispersion plot of the predicted odour impact of the new Blackmans Bay WWTP under sludge processing upset conditions (Scenario 4). The orange contour line indicates the EPA Tasmania 2 ou, 99.5th percentile assessment criteria for Scenario 4. The Scenario 1 white contour is also shown for reference.

The model predicts that the odour impact of the new WWTP under sludge processing upset conditions does not exceed the 2 ou, 99.5th percentile criteria at or beyond the future site boundary indicated in the plot (a combination of current TasWater land and land to be purchased from Council). Based on the model inputs and assumptions listed in this report, and assuming the site boundary is extended to the west and south of the existing WWTP as indicated in the figure, Scenario 4 complies with the EPA Tasmania odour criteria.
5.7 **Scenario 5: Commissioning Works**

An assessment of the predicted impact of odour emissions from the new Blackmans Bay WWTP during its commissioning phase was undertaken using odour emission data.

5.7.1 **Odour Emission Data and Assumptions**

The commissioning activities are anticipated to include the following methodology:

1. The existing primary clarifiers, bioreactor and secondary clarifier out of service as IDEA-SBR reactor 1 is used as a liquid stream process
2. The second reactor (IDEA-SBR 2) will be used as an aerobic digester during this period (while the existing bioreactor is converted to an aerobic digester).

The specific odour emission rates (ou.m/s) for the area sources estimated for Scenario 5 are shown in Table 5-5. Those for Scenario 1 are also shown for comparison. The odour emissions were assumed to be constant (i.e. 24 hours a day, 7 days a week) throughout the run period, apart from the IDEA-SBR Aeration, Anoxic and Settling/Decant phases (refer Section 5.1.1)

The specific odour emission rates for point sources are as per Scenario 1 in Section 5.1.1.

**Table 5-5: Odour emission data for area sources in Scenario 1 and Scenario 5**

<table>
<thead>
<tr>
<th>Source ID</th>
<th>Source Description</th>
<th>Source Area (m²)</th>
<th>Release Height (m)</th>
<th>Initial Sigma z (m)</th>
<th>SOER (ou.m/s)</th>
<th>Scenario 1</th>
<th>Scenario 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>INWRKS</td>
<td>Inlet Works (screenings handling, grit classifier, bins)</td>
<td>72</td>
<td>1.9</td>
<td>1</td>
<td>0.224</td>
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<td>FLWDST</td>
<td>Flow Distribution Channel</td>
<td>24</td>
<td>2.9</td>
<td>1</td>
<td>0.045</td>
<td>0.045</td>
<td></td>
</tr>
<tr>
<td>IWPUMP</td>
<td>Inlet Works Return Pump Station</td>
<td>4</td>
<td>0.0</td>
<td>1</td>
<td>0.045</td>
<td>0.045</td>
<td></td>
</tr>
<tr>
<td>GPPUMP</td>
<td>General Purpose Pump Station (centrate return)</td>
<td>7</td>
<td>0.0</td>
<td>1</td>
<td>4.470</td>
<td>4.470</td>
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</tr>
<tr>
<td>1ANOX1</td>
<td>IDEA-SBR 1 Anoxic Selector Zone</td>
<td>58</td>
<td>2.4</td>
<td>1</td>
<td>1.700</td>
<td>1.700</td>
<td></td>
</tr>
<tr>
<td>1ANOX2</td>
<td>IDEA-SBR 1 Secondary Anoxic Zone</td>
<td>192</td>
<td>2.4</td>
<td>1</td>
<td>0.695</td>
<td>0.695</td>
<td></td>
</tr>
<tr>
<td>1AERAT</td>
<td>IDEA-SBR 1 Aeration Phase</td>
<td></td>
<td>2.4</td>
<td>1</td>
<td>0.313</td>
<td>0.313</td>
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</tr>
<tr>
<td>1ANOX3</td>
<td>IDEA-SBR 1 Anoxic Phase</td>
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<td>0.695</td>
<td>0.695</td>
<td></td>
</tr>
<tr>
<td>1DECAN</td>
<td>IDEA-SBR 1 Settling / Decant Phase</td>
<td></td>
<td>2.4</td>
<td>1</td>
<td>0.076</td>
<td>0.076</td>
<td></td>
</tr>
<tr>
<td>2ANOX1</td>
<td>IDEA-SBR 2 Anoxic Selector Zone</td>
<td>58</td>
<td>2.4</td>
<td>1</td>
<td>1.700</td>
<td>0.313</td>
<td></td>
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<tr>
<td>2ANOX2</td>
<td>IDEA-SBR 2 Secondary Anoxic Zone</td>
<td>192</td>
<td>2.4</td>
<td>1</td>
<td>0.695</td>
<td>0.313</td>
<td></td>
</tr>
<tr>
<td>2AERAT</td>
<td>IDEA-SBR 2 Aeration Phase</td>
<td>1,062</td>
<td>2.4</td>
<td>1</td>
<td>0.313</td>
<td>0.313</td>
<td></td>
</tr>
</tbody>
</table>
### Source ID | Source Description | Source Area (m²) | Release Height (m) | Initial Sigma z (m) | SOER (ou.m/s) | Scenario 1 | Scenario 5
--- | --- | --- | --- | --- | --- | --- | ---
2ANOX3 | IDEA-SBR 2 Anoxic Phase | | 2.4 | 1 | 0.695 | 0.313
2DECAN | IDEA-SBR 2 Settling / Decant Phase | | 2.4 | 1 | 0.076 | 0.313
GRAVTH | Gravity Thickener | 177 | 0.0 | 1 | 0.200 | 0.200
DGAER | Aerobic Digester - Aerobic Cells | 169 | 0.0 | 1 | 0.150 | -
DIGANO | Aerobic Digester - Anoxic Cells | 169 | 0.0 | 1 | 0.300 | -
SPIROT | Dewatered Cake Self-Loading Bins | 23 | 1.5 | 1 | 0.029 | -

### 5.7.2 Assessment Results

The assessment of odour emission rates in Table 5-5 demonstrates that the emission rates for Scenario 5 are far less than for Scenario 1, which is shown in Figure 5-2 to comply with the 2 ou, 99.5 percentile criteria outside the future site boundary. CALPUFF modelling was therefore not conducted for Scenario 5 as it is not anticipated to have an impact outside the future site boundary (a combination of current TasWater land and land which may be purchased from Council).
6  Odour Assessment Summary

6.1  Predicted Odour Concentrations at Sensitive Receptors

Table 6-1 presents a summary of the predicted odour impacts at the discrete receptors representing odour-sensitive locations surrounding Blackmans Bay WWTP. Predicted 1-hour average 99.5 percentile odour concentrations for Scenarios 1-4 have been recorded to two decimal places for comparison purposes only. Receptors 1, 2 and 3 represent the nearest rural residential properties to the west of the facility, receptors 4, 5 and 6 are arbitrary points along Suncoast Drive to show the predicted odour impact at residences to the north of the facility, and receptor 7 represents the nearest rural residential property to the south west. Figure 3-2 displays the discrete receptor locations.

The predicted 99.5 percentile odour concentrations in Scenario 1 (normal operations of the new WWTP) did not exceed the EPA Tasmania 2 ou odour criterion at any of the sensitive receptor locations. Even under upset or maintenance conditions (Scenarios 2-4), the 99.5 percentile 2 ou criterion was not exceeded at these locations.

Table 6-1: Predicted 1-hour average, 99.5 percentile odour concentrations (ou) at sensitive receptors for Scenarios 1-4

<table>
<thead>
<tr>
<th>Receptor ID</th>
<th>Easting MGA X (km)</th>
<th>Northing MGA Y (km)</th>
<th>Elevation (m)</th>
<th>Predicted 1hr average, 99.5 percentile odour concentration (ou)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scenario 1</td>
<td>Scenario 2</td>
<td>Scenario 3</td>
<td>Scenario 4</td>
</tr>
<tr>
<td>1</td>
<td>526.587</td>
<td>5237.410</td>
<td>58.6</td>
<td>0.67 0.70 1.32 0.67</td>
</tr>
<tr>
<td>2</td>
<td>526.446</td>
<td>5237.377</td>
<td>71.7</td>
<td>0.30 0.31 0.54 0.30</td>
</tr>
<tr>
<td>3</td>
<td>526.407</td>
<td>5237.328</td>
<td>69.3</td>
<td>0.29 0.29 0.46 0.29</td>
</tr>
<tr>
<td>4</td>
<td>526.598</td>
<td>5237.581</td>
<td>65.9</td>
<td>0.46 0.48 0.87 0.46</td>
</tr>
<tr>
<td>5</td>
<td>526.677</td>
<td>5237.631</td>
<td>60.2</td>
<td>0.52 0.54 1.01 0.52</td>
</tr>
<tr>
<td>6</td>
<td>526.779</td>
<td>5237.651</td>
<td>46.8</td>
<td>0.55 0.57 1.09 0.55</td>
</tr>
<tr>
<td>7</td>
<td>526.382</td>
<td>5236.966</td>
<td>98.0</td>
<td>0.17 0.17 0.28 0.17</td>
</tr>
</tbody>
</table>

The predicted 100 percentile (maximum) odour concentrations for Scenarios 1-4 provided in Table 6-2 also did not exceed the EPA Tasmania 2 ou odour criterion at the identified sensitive receptors, apart from Receptor 1 in Scenario 3 with a concentration of 3.6 ou. However as discussed in Section 5.5 process upset conditions modelled throughout the year in Scenario 3 are not realistic and highly unlikely to occur.
Table 6-2: Predicted 1-hour average, 100 percentile odour concentrations (ou) at sensitive receptors for Scenarios 1-4

<table>
<thead>
<tr>
<th>Receptor ID</th>
<th>Easting MGA X (km)</th>
<th>Northing MGA Y (km)</th>
<th>Elevation (m)</th>
<th>Predicted 1hr average, 100th percentile odour concentration (ou)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Scenario 1</td>
</tr>
<tr>
<td>1</td>
<td>526.587</td>
<td>5237.410</td>
<td>58.6</td>
<td>1.84</td>
</tr>
<tr>
<td>2</td>
<td>526.446</td>
<td>5237.377</td>
<td>71.7</td>
<td>0.88</td>
</tr>
<tr>
<td>3</td>
<td>526.407</td>
<td>5237.328</td>
<td>69.3</td>
<td>0.76</td>
</tr>
<tr>
<td>4</td>
<td>526.598</td>
<td>5237.581</td>
<td>65.9</td>
<td>0.83</td>
</tr>
<tr>
<td>5</td>
<td>526.677</td>
<td>5237.631</td>
<td>60.2</td>
<td>0.89</td>
</tr>
<tr>
<td>6</td>
<td>526.779</td>
<td>5237.651</td>
<td>46.8</td>
<td>0.83</td>
</tr>
<tr>
<td>7</td>
<td>526.382</td>
<td>5236.966</td>
<td>98.0</td>
<td>0.40</td>
</tr>
</tbody>
</table>

Table 6-1 and Table 6-2 indicate that for each modelling scenario the highest 1-hour mean (as 99.5th and 100th percentile) concentration is predicted at sensitive receptor 1. However the location of this receptor lies within the future site boundary, meaning it is on land to be purchased by TasWater.

6.2 Time of Day Impacts

Modelling did not show any off-site impact for any of the scenarios likely to eventuate. As none of the sensitive receptors were in exceedance of the impact criteria, time of day impacts were not investigated further.

6.3 Management of Odour Impact during Adverse Weather Conditions

MWH have taken the term ‘adverse weather conditions’ to mean the management of storm flows. During storm flows, the retention time within the sewer decreases and wastewater tends to become more dilute, reducing the potential for odour impact.

However the first flush of storm water can deposit into the inlet works any silted sludge accumulated within the network which has the potential of being septic. This can lead to short times of higher than anticipated odour emitted from the inlet works. For a plant the size of Blackmans Bay WWTP, this rarely effects plant downstream of the inlet works.

6.4 Management of odour during biosolids export

Biosolids export has historically been an odour problem for many sites, as there is generally a sudden release of reduced sulphur compounds during outloading events. The action of conveyors and disturbance of sludge (which has turned anaerobic) during the transfer of sludge from the onsite storage hopper to a waiting truck can have significant off-site impact.

To mitigate this, the design utilizes self-loading enclosed sprotainer type bins. These are filled on demand from the centrifuges via enclosed conveyors. The spirotainers, and conveyors are ventilated at a high rate to contain odour, and the sludge is not exposed to atmosphere during its removal from
site. Odour produced from the dewatered biosolids will be contained at all times, both during on-site storage, and during its removal from site.

Odour nuisance caused by outloading events is not envisaged with this design.

6.5 Management of odour during construction

A detailed odour mitigation plan shall be produced for the construction phase of the project when the detailed construction methodology is interrogated. The odour mitigation plan will include, but not be limited too;

1. Network dosing to reduce site gas levels and potential for odour nuisance.
2. Consideration of maintaining existing odour control systems in operation as long as practicable during the construction / new plant commissioning phases to allow for treatment of odour, or the provision of temporary odour control facilities.
3. Regular re-balancing and surveillance of odour control systems during the construction period to ensure continued satisfactory operation.
4. Odour prevention, reduction and containment being a requirement in SWMS and operational plans during the construction period.
5. The prompt removal of sewage products and cleaning of vessels which are being decommissioned or re-purposed.
6. The use of atomization sprays (if required) during the de-gritting and removal of products from the digester.
7. No storage of Odorous products on site, and removal from site in a timely manner
8. Phased startup of the plant to enable the new odour control facilities to acclimatize, and use of the downstream carbon during this period to prevent odorous gas discharge.

7 Summary and Conclusions

The CALPUFF dispersion model was used to assess the predicted odour impact of the new Blackmans Bay WWTP under normal operating conditions and plant upset conditions against EPA Tasmania’s 2 ou, 99.5th percentile, 1-hour average odour impact assessment criteria. Suitable odour emission data was selected from the MWH Global Database and CALMET meteorological modelling was undertaken using surface observational data from Hobart, Dennes Point, Grove and Kunyani and upper air data from Hobart.

The modelling found that the predicted odour impact of the new Blackmans Bay WWTP:

- Did not exceed EPA Tasmania requirements beyond the future site boundary (assuming TasWater purchases land to the west and south of the existing WWTP boundary) when modelled under normal operating conditions (Scenario 1);
- Did not exceed EPA Tasmania requirements beyond the future site boundary (assuming TasWater purchases land to the west and south of the existing WWTP boundary) when modelled during scheduled maintenance at the inlet works resulting in an increase in odour emissions from the inlet works by 100% (Scenario 2);
- Exceeded EPA Tasmania requirements beyond the future site boundary (to the south of the existing WWTP boundary) when under treatment process upset conditions resulting in an increase in odour emissions from all process tanks by 100% (Scenario 3), however this is not considered to be a realistic scenario. As previously discussed, realistic scenarios resulting in increases in liquid stream emissions are unlikely to exceed EPA Tasmania requirements; and

- Did not exceed EPA Tasmania requirements beyond the future site boundary (assuming TasWater purchases land to the west and south of the existing WWTP boundary) when modelled under sludge processing upset conditions resulting in an increase in odour emissions from the dewatered cake self-loading bin by 100% (Scenario 4).

- Is likely to not exceed EPA Tasmania requirements beyond the future site boundary (assuming TasWater purchases land to the west and south of the existing WWTP boundary) when modelled under commissioning conditions, with commissioning activities as listed in Scenario 5.

It should be noted that emission rates were estimated / derived by MWH utilising the MWH emissions database. Whilst this historically produces datasets within 10% of measured emissions, there is a risk that odour emissions may be higher or lower than estimated and a resulting risk of odour impacts. It is recommended that TasWater verify the odour emission rates and capture efficiencies of covered process units when the site is operational to validate the odour modelling.
Appendix A  Tender Design Site Layout Drawing
Appendix B  Odour Source Model Input Tables
## Table B-1: Odour sources in Scenario 1 - Normal Operations of New WWTP

<table>
<thead>
<tr>
<th>Source Description</th>
<th>Source ID</th>
<th>Source ID Type</th>
<th>Surface Area</th>
<th>Base Elevation (m)</th>
<th>Effective Release Height (m)</th>
<th>Estimated SOER (ou.m/s)</th>
<th>Covered / Extracted From</th>
<th>Capture Rate Note4</th>
<th>Modelled SOER Note5</th>
<th>OER Note6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Works (screenings handling, grit classifier, bins)</td>
<td>INWRKS</td>
<td>Area</td>
<td>72</td>
<td>48.5</td>
<td>1.9</td>
<td>4.47</td>
<td>Y</td>
<td>95%</td>
<td>0.224</td>
<td>16</td>
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<tr>
<td>Flow Distribution Channel</td>
<td>FLWDST</td>
<td>Area</td>
<td>24</td>
<td>44.6</td>
<td>2.9</td>
<td>4.47</td>
<td>Y</td>
<td>99%</td>
<td>0.045</td>
<td>1</td>
</tr>
<tr>
<td>Inlet Works Return Pump Station</td>
<td>IWPUMP</td>
<td>Area</td>
<td>4</td>
<td>49.8</td>
<td>0.0</td>
<td>4.47</td>
<td>Y</td>
<td>99%</td>
<td>0.045</td>
<td>0.2</td>
</tr>
<tr>
<td>General Purpose Pump Station (centrate return)</td>
<td>GPPUMP</td>
<td>Area</td>
<td>7</td>
<td>32.7</td>
<td>0.0</td>
<td>4.47</td>
<td>N</td>
<td>0%</td>
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<tr>
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<td>1ANOX1</td>
<td>Area</td>
<td>58</td>
<td>43.0</td>
<td>2.4</td>
<td>1.70</td>
<td>N</td>
<td>0%</td>
<td>1.700</td>
<td>99</td>
</tr>
<tr>
<td>IDEA-SBR 1 Secondary Anoxic Zone</td>
<td>1ANOX2</td>
<td>Area</td>
<td>192</td>
<td>43.0</td>
<td>2.4</td>
<td>0.695</td>
<td>N</td>
<td>0%</td>
<td>0.695</td>
<td>133</td>
</tr>
<tr>
<td>IDEA-SBR 1 Aeration Phase</td>
<td>1AERAT</td>
<td>Area</td>
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<td>43.0</td>
<td>2.4</td>
<td>0.313</td>
<td>N</td>
<td>0%</td>
<td>0.313</td>
<td>time-variable emission</td>
</tr>
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<td>0.076</td>
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<td>0%</td>
<td>0.076</td>
<td>time-variable emission</td>
</tr>
<tr>
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<td>N</td>
<td>0%</td>
<td>0%</td>
<td>1.700</td>
<td>99</td>
</tr>
<tr>
<td>IDEA-SBR 2 Anoxic Selector Zone</td>
<td>2ANOX1</td>
<td>Area</td>
<td>58</td>
<td>44.6</td>
<td>2.4</td>
<td>1.70</td>
<td>N</td>
<td>0%</td>
<td>1.700</td>
<td>99</td>
</tr>
<tr>
<td>IDEA-SBR 2 Secondary Anoxic Zone</td>
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<td>Area</td>
<td>192</td>
<td>44.6</td>
<td>2.4</td>
<td>0.695</td>
<td>N</td>
<td>0%</td>
<td>0.695</td>
<td>133</td>
</tr>
<tr>
<td>IDEA-SBR 2 Aeration Phase</td>
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<td>Area</td>
<td>1,062</td>
<td>44.6</td>
<td>2.4</td>
<td>0.313</td>
<td>N</td>
<td>0%</td>
<td>0.313</td>
<td>time-variable emission</td>
</tr>
<tr>
<td>IDEA-SBR 2 Anoxic Phase</td>
<td>2ANOX3</td>
<td>Area</td>
<td>44.6</td>
<td>2.4</td>
<td>0.695</td>
<td>N</td>
<td>0%</td>
<td>0%</td>
<td>0.695</td>
<td>time-variable emission</td>
</tr>
<tr>
<td>IDEA-SBR 2 Settling / Decant Phase</td>
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<td>Area</td>
<td>44.6</td>
<td>2.4</td>
<td>0.076</td>
<td>0.076</td>
<td>N</td>
<td>0%</td>
<td>0.076</td>
<td>time-variable emission</td>
</tr>
<tr>
<td>Gravity Thickener</td>
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<td>Area</td>
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<td>0.20</td>
<td>N</td>
<td>0%</td>
<td>0.200</td>
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</tr>
<tr>
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<td>DGAER</td>
<td>Area</td>
<td>169</td>
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<td>0.15</td>
<td>N</td>
<td>0%</td>
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<tr>
<td>Aerobic Digester - Anoxic Cells</td>
<td>DIGANO</td>
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<td>0.30</td>
<td>N</td>
<td>0%</td>
<td>0.300</td>
<td>51</td>
</tr>
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<td>Source Description</td>
<td>Source ID</td>
<td>Source Type</td>
<td>Surface Area</td>
<td>Base Elevation note1</td>
<td>Effective Release Height note2</td>
<td>Estimated SOER note3</td>
<td>Covered / Extracted From</td>
<td>Capture Rate note4</td>
<td>Modelled SOER note5</td>
<td>OER note6</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------</td>
<td>-------------</td>
<td>--------------</td>
<td>----------------------</td>
<td>-----------------------------</td>
<td>----------------------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Dewatered Cake Self-Loading Bins</td>
<td>SPIROT</td>
<td>Area</td>
<td>23</td>
<td>33.8</td>
<td>1.5</td>
<td>29.38</td>
<td>Y</td>
<td>99.9%</td>
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<td>0.7</td>
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<td>Odour Control Facility Stack</td>
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<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>901</td>
</tr>
</tbody>
</table>

Note 1: Elevations sourced from SRTM3 terrain data

Note 2: Above ground level, taken from drawings and information provided by TYR Group

Note 3: Estimated SOER = specific odour emission rate (taken from MWH database)

Note 4: Percentage of emissions captured by odour covers or contained in a building/structure

Note 5: Modelled SOER = specific odour emission rate (used in model) = estimated SOER x (1-(capture rate/100))

Note 6: OER = odour emission rate = modelled SOER x surface area (area sources); or volumetric air flow x odour concentration (volume/point sources)
Table B-2: Odour sources in Scenario 2 - Inlet Works Maintenance Period for New WWTP

<table>
<thead>
<tr>
<th>Source Description</th>
<th>Source ID</th>
<th>Source Type</th>
<th>Surface Area</th>
<th>Base Elevation note1 (m²)</th>
<th>Effective Release Height note2 (m)</th>
<th>Estimated SOER note3 (ou.m/s)</th>
<th>Inlet Works Maintenance SOER note3</th>
<th>Covered / Extracted From</th>
<th>Capture Rate note4 (%)</th>
<th>Modeled SOER note5 (ou.m/s)</th>
<th>OER note6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Works (screenings handling, grit classifier, bins)</td>
<td>INWRKS</td>
<td>Area</td>
<td>72</td>
<td>48.5</td>
<td>1.9</td>
<td>4.47</td>
<td>8.94</td>
<td>Y</td>
<td>95%</td>
<td>0.447</td>
<td>32</td>
</tr>
<tr>
<td>Flow Distribution Channel</td>
<td>FLWDST</td>
<td>Area</td>
<td>24</td>
<td>44.6</td>
<td>2.9</td>
<td>4.47</td>
<td>8.94</td>
<td>Y</td>
<td>99%</td>
<td>0.089</td>
<td>2</td>
</tr>
<tr>
<td>Inlet Works Return Pump Station</td>
<td>IWPUMP</td>
<td>Area</td>
<td>4</td>
<td>49.8</td>
<td>0.0</td>
<td>4.47</td>
<td>8.94</td>
<td>Y</td>
<td>99%</td>
<td>0.089</td>
<td>0.3</td>
</tr>
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<td>0.695</td>
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<td>0%</td>
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<td>0%</td>
<td>0.076</td>
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Note 1: Elevations sourced from SRTM3 terrain data
Note 2: Above ground level, taken from drawings and information provided by TYR Group
Note 3: Estimated SOER = specific odour emission rate (taken from MWH database)
Note 4: Percentage of emissions captured by odour covers or contained in a building/structure
Note 5: Modelled SOER = specific odour emission rate (used in model) = estimated SOER x (1-(capture rate/100))
Note 6: OER = odour emission rate = modelled SOER x surface area (area sources); or volumetric air flow x odour concentration (volume/point sources)
<table>
<thead>
<tr>
<th>Source Description</th>
<th>Source ID</th>
<th>Source Type</th>
<th>Surface Area</th>
<th>Base Elevation (^{\text{note1}}) (m)</th>
<th>Effective Release Height (^{\text{note2}}) (m)</th>
<th>Estimated SOER (^{\text{note3}}) (ou.m/s)</th>
<th>Process Upset SOER (^{\text{note3}}) (ou.m/s)</th>
<th>Covered / Extracted From</th>
<th>Capture Rate (^{\text{note4}}) (% or ou.m/s)</th>
<th>Modelled SOER (^{\text{note5}}) (ou.m/s)</th>
<th>OER (^{\text{note6}}) (ou.m(^3)/s)</th>
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<td>Inlet Works (screenings handling, grit classifier, bins)</td>
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<td>8.94</td>
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<td>Y</td>
<td>99%</td>
<td>0.089</td>
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<tr>
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<td>32.7</td>
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<td>4.47</td>
<td>8.94</td>
<td>N</td>
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<td>N</td>
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<td>1.39</td>
<td>N</td>
<td>0%</td>
<td>1.390</td>
<td>267</td>
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<td>IDEA-SBR 2 Aeration Phase</td>
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<td>44.6</td>
<td>2.4</td>
<td>0.313</td>
<td>0.63</td>
<td>N</td>
<td>0%</td>
<td>0.626</td>
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<td>N</td>
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<td>Y</td>
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\(^{\text{note1}}\) Base Elevation (m) for each source is provided.

\(^{\text{note2}}\) Effective Release Height (m) for each source is provided.

\(^{\text{note3}}\) Estimated SOER (ou.m/s) for each source is provided.

\(^{\text{note4}}\) Capture Rate (\% or ou.m/s) for each source is provided.

\(^{\text{note5}}\) Modelled SOER (ou.m/s) for each source is provided.

\(^{\text{note6}}\) OER (ou.m\(^3\)/s) for each source is provided.
Note 1: Elevations sourced from SRTM3 terrain data
Note 2: Above ground level, taken from drawings and information provided by TYR Group
Note 3: Estimated SOER = specific odour emission rate (taken from MWH database)
Note 4: Percentage of emissions captured by odour covers or contained in a building/structure
Note 5: Modelled SOER = specific odour emission rate (used in model) = estimated SOER x (1-(capture rate/100))
Note 6: OER = odour emission rate = modelled SOER x surface area (area sources); or volumetric air flow x odour concentration (volume/point sources)
Table B-4: Odour sources in Scenario 4 - Sludge Processing Upset for New WWTP

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<th>Source Description</th>
<th>Source ID</th>
<th>Source Type</th>
<th>Surface Area</th>
<th>Base Elevation note 1 (m²)</th>
<th>Effective Release Height note 2 (m)</th>
<th>Estimated SOER note 3 (ou.m/s)</th>
<th>Sludge Upset SOER note 4 (ou.m/s)</th>
<th>Covered / Extracted From</th>
<th>Capture Rate note 5 (ou.m/s)</th>
<th>Modeled SOER note 6 (ou.m³/s)</th>
<th>OER note 6</th>
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<td>N</td>
<td>0%</td>
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<td>27.1</td>
<td>0.0</td>
<td>0.30</td>
<td>n/a</td>
<td>N</td>
<td>0%</td>
<td>0.300</td>
<td>51</td>
</tr>
<tr>
<td>Dewatered Cake Self-Loading Bins</td>
<td>SPIROT</td>
<td>Area</td>
<td>23</td>
<td>33.8</td>
<td>1.5</td>
<td>29.38</td>
<td>58.76</td>
<td>Y</td>
<td>99.9%</td>
<td>0.059</td>
<td>1.3</td>
</tr>
<tr>
<td>Odour Control Facility Stack</td>
<td>BTFCOF</td>
<td>Point</td>
<td></td>
<td>35.8</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>901</td>
</tr>
</tbody>
</table>
Note 1: Elevations sourced from SRTM3 terrain data

Note 2: Above ground level, taken from drawings and information provided by TYR Group

Note 3: Estimated SOER = specific odour emission rate (taken from MWH database)

Note 4: Percentage of emissions captured by odour covers or contained in a building/structure

Note 5: Modelled SOER = specific odour emission rate (used in model) = estimated SOER x (1-(capture rate/100))

Note 6: OER = odour emission rate = modelled SOER x surface area (area sources); or volumetric air flow x odour concentration (volume/point sources)
Appendix C  Input Meteorological Data Report
Development of a Meteorological Modelling Data Set for Blackmans Bay Wastewater Treatment Plant, Tasmania

July 2016

Prepared For:
TYR Group on behalf of TasWater
Hobart
Tasmania

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EXECUTIVE SUMMARY

Meteorological Modelling for a full year period in 2015 has been conducted for Blackmans Bay Wastewater Treatment Plant (WWTP) in Tasmania, hereafter referred to as Blackmans Bay STP. Meteorological data from the year 2015 was chosen as it represents a recent year in a neutral El Nino year. The meteorological data set has been custom built to the Blackmans Bay site. The meteorological model has used hourly observational data from the Bureau of Meteorology’s four nearest meteorological stations which are Dennes Point, Hobart, Kunyani and Grove plus a single upper air station, Hobart Airport. Two models, the Australian CSIROs the Air Pollution Model (TAPM) and CALMET, the diagnostic meteorological component of the CALPUFF suite of models, were used to develop the meteorological data set at the STP. Both models are recognised as guideline models in Australia and New Zealand. Hourly observational data of temperature, wind speed, direction, relative humidity and pressure were obtained from all four of the meteorological stations.

As well as preparation of a one year meteorological data set, an analysis has been conducted on two historic data sets that have been used in previous air analyses. The first is a December 2004 - December 2005 AUSPLUME-prepared meteorological data set from monitored data at Blackmans Bay. The second is an AUSPLUME data set derived from TAPM data for 2006 which was used in odour modelling in 2014. An evaluation of the monitored on-site data for 2005 suggests that the wind direction has been incorrectly reported in the AUSPLUME meteorological file, and is likely to be 180 degrees out. This error was not picked up in the 2014 modelling, and Blackmans Bay data was ruled as ‘unsuitable’ as the anemometer is located on a building and does not meet the Australian Wind monitoring standards. However, when the wind direction data is corrected, the data appears sound and reasonable and is acceptable for use in modelling. The second data set, the 2006 AUSPLUME data set that was developed from TAPM data at the Blackmans Bay site was used in the 2014 modelling. However, an in-depth analysis showed that the flow was constantly dominated by westerly winds - even during the day when onshore sea breezes are common daily occurrence especially in summer.

The new 2015 data, built for this air assessment has been exclusively developed from nearby observation stations and Hobart Upper Air Data. TAPM 2015 data did not perform well and has mostly been excluded from 2015 modelling. On evaluation of the CALMET model output at Blackmans Bay, there is a tendency for the wind patterns to look fairly similar to Dennes Point. This is reasonable and expected due to the nearness of Dennes Point to the STP. The important summertime and wintertime diurnal cycles are well represented at Blackmans Bay STP, whereas they were not in the earlier data sets.

Development of a meteorological data set at Blackmans Bay STP is highly complex due to the large scale topographic features upwind, the effects of the Peninsula, the sea breeze and the local topography around the facility. It is a challenge to develop a meteorological data set at such a complex site. Hence it is highly recommended to re-instate a meteorological station at Blackmans Bay STP to support future work. Further, TasWater may elect to correct the 2005 on-site AUSPLUME meteorological data, and then use it directly in CALPUFF to provide robustness to the 2015 modelling and to account for inter annual variability.
1 INTRODUCTION

1.1 BACKGROUND

TYR Group has engaged Jennifer Barclay to develop a meteorological data set in order to assess odours from the Blackmans Bay STP. This report provides a detailed analysis of the meteorological data set development for the STP.

1.2 PURPOSE OF THIS REPORT

The purpose of this report is to provide technical details of the methods used to develop and evaluate a one year meteorological data set for Blackmans Bay STP. Further an analysis of two historic data sets has been evaluated. These are the onsite 2005 AUSPLUME data set and the 2006 TAPM derived AUSPLUME data set used in the 2014 modelling by Consulting Environmental Engineers (CEE).

This report provides TasWater with:

- A suitable and reliable meteorological data set to use for use at Blackmans Bay for all air modelling purposes both for the current set of conditions as well for any future developments at the facility.
- Confidence that the meteorological data has been prepared using state of science methods and models
- Technical document outlining the methods used to develop the 2015 Meteorological data set
- A detailed evaluation of past meteorological data used for the STP
- A detailed evaluation of the predicted model performance for 2015

1.2.1 Other relevant reports and Data

The following historical documents have been evaluated and assessed in my analysis of historic meteorological modelling conducted at Blackmans Bay.

- Report on Odour Modelling for Blackmans Bay Wastewater Treatment Plant, April 2014, Consulting Environmental Engineers.
- AUSPLUME meteorological data set- Blackmans Bay Site Winds -0405.met (supplied via email from D. Fligelman from Ian Wallis on the 15 July 2016.
- TAPM 2006 AUSPLUME Met Data set used in Consulting Environmental Engineers (CEE) 2014 Modelling Report.

An AUSPLUME December 2004 – December 2005 meteorological data set was developed sometime after the data was collected and is the basis of several figures in the CEE, 2014 odour modelling report. No modelling using this original on-site data set has been provided, and we are not aware of any modelling undertaken prior to the CEE 2014 report.

Consulting Environmental Engineers conducted modelling in 2014 after developing a TAPM derived AUSPLUME meteorological data for the year 2006 set at the site of the Blackmans Bay STP. The 2014 CEE report did not use the on-site meteorology, based on the observation that “The Blackmans Bay monitoring station is attached to the top of a building and does not meet the Australian Standards for wind monitoring”.

No sophisticated three-dimensional modelling appears to have been undertaken at the Blackmans Bay site.

1.3 SCOPE OF REPORT

The development of a one year meteorological data set for Blackmans Bay STP includes the following tasks;

1. Establish regional climate and site specific atmospheric dispersion potential.
2. Identify the local meteorological patterns at the Blackmans STP site and their capture in the meteorological model
3. Evaluate the historic meteorological data sets and previous modelling to
4. Develop the best upper air data set suitable for dispersion of odour above 20m
5. Develop a realistic model grid resolution that allows a detailed description of the terrain immediately around the facility as well as the larger scale topography.
6. Preparation of a draft report which summarises the methodology and findings of the study in Technical Report.
7. Analyse all comments and submit a final report

This report includes the outcomes from items 1-6 listed above.
2 SITE DESCRIPTION AND HISTORIC DATA ANALYSIS

2.1 LOCATION

The Blackmans Bay STP is located some 15km south of Hobart. Figure 2-1 shows the current location of the facility. The STP is located at approximately 30 m above sea level. Immediately around the facility the terrain rises to over 150m within just 800m or so from the STP. The STP is located in a depression, or an open gully. To the north the terrain rises up to a ridge at approximately 80m about 300m from the plant and to the south the terrain rises up to more than 100m about 600m from the plant. Significant terrain >700m is within 15km of the STP site to the west.

![Figure 2-1: Blackmans Bay Wastewater Treatment Plant.](image)

2.2 HISTORIC DATA ANALYSIS

Unfortunately there is no recent on-site meteorological data of value to the meteorological data development. Wind speed, wind direction and temperature was collected during December 2004 to December 2005, and developed into an AUSPLUME meteorological data set. This data set has been referenced by CEE in their 2014 Odour Modelling report. The annual Blackmans Bay STP wind rose presented in the CEE 2014 report is shown below on the left hand side of Figure 2-2. Odour modelling was conducted at Blackmans Bay Treatment plant by CEE in 2014, but did not use the 2005 Blackmans Bay data siting that the measured data does not meet the Australian Standards for wind monitoring as the instruments are placed on the building. Instead CEE developed a TAPM derived AUSPLUME meteorological data set for 2006 at the site of the STP. The CEE report provided an annual wind rose of the 2006 TAPM data set at the site of the Blackmans Bay STP. This is shown in figure 9 of the 17B.3a CEE-BB Odour Report April 2014.pdf and below in Figure 2-2 on the right hand side.

There are two striking points about the data;
1) The 2005 monitored Blackmans Bay data shows almost 90% easterly flow throughout the year and,
2) The 2006 TAPM derived flows show almost 90% westerly flow for 2006.

CEE used the 2006 AUSPLUME met file in their modelling. Neither of these are representative of the Blackmans Bay site. Further analysis of the original 2005 AUSPLUME met data set shows that the wind directions are likely 180 degrees incorrect. It seems that the wind directions have been incorrectly reported in the AUSPLUME meteorological files as wind directions ‘blowing towards’ instead of winds ‘blowing from’. Winds, ‘blowing towards’ are consistent with the old outdated Industrial Source Complex Model (ISCST3) model formats, but not AUSPLUME. See Attachment A which shows that the wind roses are the same in the original 2005 AUSPLUME data set as those reported in the CEE report.
2005 Annual Blackmans Bay wind rose, which has
been corrected.

Figure 2-3: Corrected 2005 Blackmans Bay Annual wind rose on left hand side with 2006 data
used in the modelling by CEE in 2014.

When the wind direction is corrected then the Blackmans Bay winds looks much more realistic
of the annual flow conditions that you would expect at Blackmans Bay and also looks much
more similar to the 2006 TAPM derived data set used in the CEE 2014 modelling, (with the
exception of no easterly flow from the TAPM 2006 data set).

An analysis of the 2006 TAPM derived AUSPLUME data set used in the CEE 2014 modelling
shows that this data set is not suitable for Blackmans Bay. Attachment B shows the seasonal
and time of day roses from the TAPM derived data set. All the wind directions are from the
west and west south west with almost no north, east or southerly flow at all. This is not
possible. The Blackmans Bay STP is located on the east coast of Tasmania and diurnal sea
and land breezes are just part of the normal daily cycle. During the daytime, especially in summer
onshore easterlies will occur beginning at around 10am or earlier and gradually swinging to be
from the northeast in the late afternoon before collapsing around sunset where after the
nocturnal offshore land breeze occurs during the night. It is not clear why TAPM does not pick
up the easterly flow but it is possible that TAPM is over predicting the offshore land breeze
flow due to the over development of the katabatic flows off Mt Wellington which is located
just 15km to the west of Blackmans Bay.

2.3 METEOROLOGY OF BLACKMANS BAY

The meteorology at Blackmans Bay is complex - both on a local scale and on a larger regional
scale. On the regional scale, the facility is located on a Peninsula that juts out into the large
open Hobart Harbour. The coastline within the harbour is convoluted and significant
topography > 1000m exists within 15km to the west of the STP. On a local scale the STP is
located in a wide open gully, with elevated terrain 50m or higher than the STP to the north,
west and south of the facility.

The dominant flow at Blackmans Bay STP is from the west and southwest. In wintertime and
at night time (throughout the year) the flow is almost entirely from the west and west south
west. On a daily diurnal cycle, offshore land breezes occur every night. These stable offshore
flows are further assisted by katabatic flows off the higher topography to the west of the STP. In winter on shore sea breeze flows are weak due to small land/sea temperature differences and the offshore flows tend to dominate throughout the diurnal cycle. In the summer on shore sea breezes are common during the daytime and occur regularly on the daily diurnal cycle.

The meteorological conditions at Blackmans Bay are described in the corrected 2005 wind roses of Figure 2-4 below.
Figure 2-4: Corrected 2005 Blackmans Bay wind roses. Wind is ‘blowing from’.
3 METEOROLOGICAL MODELLING

3.1 CALPUFF SUITE OF MODELS

CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model used to simulate the effects of time and space-varying meteorological conditions on pollutant transport. It consists of three main components: CALMET (a diagnostic 3-dimensional meteorological model), CALPUFF (an air quality dispersion model), and CALPOST (a post-processing package). Geophysical data including land use and terrain elevations at 200 m resolution are also processed and introduced into the wind field.

CALMET is a diagnostic meteorological model that is able to use both modelled (Predicted) weather model data and surface observations. (Predicted modelled data can be used to describe the upper air from 20m above the surface to 3000m above the surface when no suitable upper air data is available). The output of CALMET is hourly varying meteorological data generated for every grid cell for 2015 both in the vertical and horizontal direction. The meteorological data is the combined effect of the initial guess wind field derived from the observations and the final wind field which includes weighted surface observation data. Upper air data from Hobart has been used. Cloud ceiling height and cloud cover were expected to be sourced from Hobart Airport, but unfortunately none was available. TAPM cloud cover and cloud ceiling height have been used at the location of Hobart Airport.

CALMET is recommended for use in all applications experiencing one or more of the following, all of which are relevant to the Blackmans Bay STP:

- Coastal environments e.g. sea breeze circulations and coastal fumigation
- Complex terrain, non-steady state conditions
- Surface temperature inversions
- Extensive periods of calm or light winds.


In order to capture important coastal and terrain-induced flows, CALMET was used to develop the 3-dimensional hourly gridded meteorological domain. Inputs into CALMET included fine-scale terrain (200 m resolution), nested land use data, surface observations and upper air data from Hobart Airport. 1km gridded TAPM data was evaluated for use in the modelling but was deemed unfit for purpose. TAPM is Australia CSIRO’s Division of Atmospheric Research, ‘The Air Pollution Model’. The latest versions of the model have been used. These include CALMET Version 6.5.0, Level 150223 and CALPUFF Version 7.2.1, Level 150618.

3.1.1 Model Inputs

The following details were used to develop the 2015 meteorological model:

CALMET

- A 26.4 km x 29.4 km meteorological model domain with 200m spacing over which the 3-dimensional wind and temperature field were created. A total of 132 grid cells in the X direction and 147 grid cells in the Y direction. The southwest corner coordinates are 513.63 km and 5224.971 km in the X and Y directions, respectively. The model uses a UTM coordinate system with the WGS-84 worldwide Datum. The meteorological data set was developed from 4 nearby hourly surface stations; Dennes Point, Hobart Airport, Grove and Kunyani. Upper air data from Hobart was used to develop the upper air flow and temperature profile. Eleven vertical levels were chosen.

TAPM
The TAPM air pollution model was initially used to develop gridded 3-dimensional upper air data to provide CALMET with an initial guess wind field. TAPM was run with four nested grids. The outer nest was 36km, followed by a 12km nest inside the 36km nest, followed by a 4km nest and then lastly a 1km innermost nest. The TAPM model domain was centred on 43° 0' 00" S and 147° 19.5' 00" E. The model domains assumed 35 x 35 grid cells and 35 vertical levels. The outer TAPM domain covers a region of 1260 km x 1260 km. TAPM data was evaluated for use in CALMET as both an hourly gridded 3-dimensional data set or as individual vertical profiles to supplement the Hobart Radiosonde data. Unfortunately an evaluation of the TAPM data showed that it was not performing well, so TAPM data either as gridded data or as individual vertical profiles has not been used in the modelling. The TAPM data at the location of Hobart Airport has been used to provide cloud cover and cloud ceiling height as this was not provided even after request to Bureau of Meteorology for Hobart Airport.

A geophysical dataset including terrain and land use data to simulate the effects of the land surface on plume dispersion. The SRTM (Shuttle Radar Topography Mission) terrain data has a resolution of approximately 90 m. Land use data was obtained from the United States Geological Survey (USGS).

3.2 LAND USE AND TERRAIN

The local land use around the Blackmans Bay STP consists of mixed agricultural land, pasture, rangeland and urban areas. Forested areas are more prevalent to the west. Urban areas around the STP are mostly residential. These land uses support a medium population density.

Terrain data used in the model is 90m SRTM3 satellite data. The gridded x (east-west), y (north-south) and z (elevation) data is representative of the local terrain within the modelling domain and assists in simulating the effects of land surface elevations on plume dispersion. Figure 3-1 shows a terrain map of the entire region surrounding the STP. The CALMET model domain is shown as the first outer magenta rectangle and the recommended CALPUFF domain is shown as the innermost magenta rectangle. Figure 3-2 shows the CALMET model domain as well as the dominant Land Use types used in the model, terrain contours and the location of the surface stations used in the modelling.
Figure 3-1 shows the local and regional topographic and coastline features affecting the meteorology at Blackmans Bay STP. The outer magenta rectangle represents the CALMET model domain and the inner rectangle represents the recommended CALPUFF computational grid.
Figure 3-2: Land use and terrain contours.
4 CALMET OUTPUT

4.1 WIND SPEED AND DIRECTION

Figure 4-1 shows the annual, seasonal and time of day wind roses at Blackmans Bay as developed by CALMET for 2015. Dennes Point, the closest observation station which is approximately 5km to the south of the STP is also shown for brevity. Attachment C (Section 7) also shows the annual, seasonal and time of day wind roses for each of the surface stations used in the modelling.

(Note that the wind rose is a graphical representation of the wind speed and direction. The direction of the arm shows the direction from which the wind is blowing, the width of the arm segments shows the speed of the wind, and the length of the arm shows the proportion of the time that wind speed is blowing from that direction).

The CALMET wind roses are similar to those of Dennes Point which is not surprising due to their close location. The dominant flow at both stations is west and west south west flow. Easterly flows are infrequent and only occur for a short time in the morning between 07h00 and 12h00 and in the afternoon between 13h00 and 18h00. At Blackmans Bay STP, easterly flow occurs for 25% of all winds during the summer months, but only 1.8% of all winds during the winter months. Easterly flows account for 11.5% of all data between 07h00 and 12h00 and 30.5% of all data between 13h00 and 18h00. Light south and south easterly winds (<1.8 m/s) occur between the hours of 13h00 and 00h00 and account for 4.6% of all winds.

It is understood that odour complaints occur on the ridge to the north north west of the STP and that complaints have occurred mostly in the late afternoon and early evening. Worst case odour conditions can be expected anytime of the day when the winds are light from the south or south east. They are also likely to occur at any time in the day when there is a major change in wind direction and wind speed. Typically, when the wind speed drops the wind direction becomes highly variable. This wind speed and direction change can happen in the evenings around sunset when the mixing height collapses and in the early morning hours around sunrise and for a few hours afterward. Worst case odour dispersion conditions can also occur with the onset of local upslope flows during the morning hours.

![Dennes Point Annual Wind Rose](image1)

![Blackmans Bay CALMET, 2015, Annual Wind Rose](image2)
Figure 4-1: Annual, Seasonal and time of day Wind Roses from the Wiri Meteorological site, 2010.
The wind direction is read as the wind blowing ‘from’. Hence, the afternoon wind rose for Wiri shows dominant flows from the southwest.

4.4.1 Calm and Light Winds

Worst case odour dispersion is usually associated with calm and light wind speed events. Under these conditions, odour stagnates and accumulates and will only be advected under either mechanical or convective conditions. Mechanical conditions could be at night or convective conditions after sunrise during the day. An analysis of the light winds at Blackmans Bay STP are analysed and presented below in Table 4-1. It is important to note that there are very few complete calm events at the STP, but the wind is often light, with the onsite data recording up to 42% of all night time hours (01h-06h) in the range of 1 – 2.1 m/s.

Table 4-1: Calm and light wind speed events between the CALMET Model (2015) and Blackmans Bay onsite data in 2005.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>0.1–0.5 m/s %</th>
<th>0.5–1.0 m/s %</th>
<th>1–2 m/s %</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALMET 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>0.05%</td>
<td>1.6%</td>
<td>5%</td>
<td>14%</td>
</tr>
<tr>
<td>Winter</td>
<td>0.14%</td>
<td>1.9%</td>
<td>4.2%</td>
<td>15%</td>
</tr>
<tr>
<td>01h – 06h</td>
<td>0.05%</td>
<td>1.74%</td>
<td>5%</td>
<td>17%</td>
</tr>
<tr>
<td>07h - 12h</td>
<td>0.1%</td>
<td>1.7%</td>
<td>5.3%</td>
<td>17%</td>
</tr>
<tr>
<td>13h – 18h</td>
<td>0.05%</td>
<td>1.3%</td>
<td>3%</td>
<td>9.6%</td>
</tr>
<tr>
<td>19h – 00h</td>
<td>0.2%</td>
<td>2.4%</td>
<td>5.6%</td>
<td>18%</td>
</tr>
<tr>
<td>Blackmans Bay 2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01h – 06h</td>
<td>0%</td>
<td>42.0%</td>
<td></td>
<td>42.0%</td>
</tr>
<tr>
<td>07h - 12h</td>
<td>0%</td>
<td>29.9%</td>
<td></td>
<td>29.9%</td>
</tr>
<tr>
<td>13h – 18h</td>
<td>0%</td>
<td>14.9%</td>
<td></td>
<td>14.9%</td>
</tr>
<tr>
<td>19h – 00h</td>
<td>0%</td>
<td>30.9%</td>
<td></td>
<td>30.9%</td>
</tr>
</tbody>
</table>

*1 the 2005 Blackmans Bay STP data set is in AUSPLUME format. AUSPLUME does not read any wind speed <0.5 m/s. It is not known if the true number of calms (<0.5 m/s) have been removed from the data set, or they have been increased to be equal to 0.5 m/s.

Other important points gleaned from the analysis of the 2015 CALMET output at Blackmans Bay and the 2005 Blackmans Bay data are detailed below.

For Summer:

- 27.6% of all the data (January, February, December 2015) is from an easterly direction with a wind speed of between 3 – 5 m/s. This mostly happens between the hours of 13h – 18h and is consistent with afternoon sea breezes.
- 36.9% of all summer time flow is from a westerly direction (W, SW and WSW) with wind speeds > 5 m/s. This mostly occurs during the night between 19h-06h. This flow is consistent with nocturnal drainage flows commonly called Katabatic winds. A katabatic wind carries high density air from a higher elevation down a slope under the force of gravity. These winds originate from radiational cooling of air on top of the elevated terrain west of the STP. As the air density is inversely proportional to temperature the air flows downwards and is usually stronger in summer.
• Westerly flow in the range 0.1 – 5 m/s can also occur at other times of the day in summer and is likely due to synoptic conditions.

For Winter:
• In winter 27.6% of all the winter data (June, July, August) is from a westerly direction (W, SW and WSW) in the range 3 – 5 m/s, and;
• 33% of all winter W, SW and WSW flow is > 5 m/s. This percentage is lower than in summer where nearly 37% of all summertime westerly flow is > 5m/s. The reason for this is largely temperature driven, and drainage flows during winter may not be as strong.
• The westerly flow in winter is much more evenly spread between all the wind speed ranges than during the summer months.

4.2 REPRESENTATIVE YEAR
2015 was chosen as the representative year for modelling due to it being a recent year. Wind instruments, and information about the sites is readily available and the equipment is more likely to be new and more accurate than less recent years. 2015 was a neutral El Nino year. For model robustness and to examine inter-annual variability I recommend adding the 2005 Blackmans data as a second model year. It is advisable to begin with the raw meteorological data records and correct both the wind direction likely 180 degree error and calm winds < 0.5 m/s.

4.3 CALMET – GENERATED SPATIAL WIND FIELDS
Figure 4-2 shows a spatial distribution plot of the 10m wind field as created by CALMET using a combination of surface observations (Dennes Point, Grove, Hobart Airport and Kunyani). The plot provides a snap shot of the surface level winds across the CALMET modelling domain for a single hour of the CALMET model run (3 January hour 03h). The length of the wind vector represents the wind speed; the longer the vector, the stronger the wind speed. The range of wind speed in Figure 4-2 is from < 1 m/s to 12 m/s. Only every 9th wind vector is shown.

The spatial wind field plot is a representation of stable atmospheric conditions. At the site of the STP the winds are very light and highly variable. However, on top of the elevated terrain to the west, the flow is strongly west. Strong flow at high elevations is consistent with low pressure across the mountain tops. These strong terrain driven westerly flows have a significant impact on wind patterns at Blackmans Bay STP and are responsible for most of the west winds at the STP throughout the year.

4.4 UPPER AIR DATA
Upper air data from Hobart Airport has been used to develop the upper air wind field above 20m. Figure 4-2 shows the quantity of Radiosonde profiles during 2015 and the times that they occurred in UTC time. The Radiosonde data was mostly of a good quality with enough soundings happening prior to sunrise and around sunset to make the data useful.

Upper air data is critical in determining the temperature profile and for developing the 3-dimensional wind flow above the surface. Three dimensional gridded TAPM data was originally developed to provide the three dimensional wind field to CALMET. However, an evaluation of the quality of the 2015 TAPM data showed that it was not doing well at the nearest observation site to the STP, Dennes Point. The statistical evaluation is shown in Attachment D, Section 9 of this report. Briefly, only between 34% and 42% of all the data analysed met the statistical bench mark values for wind speed and direction. TAPM failed
the wind speed Root Mean Square Error (RMSE) bench of < 2 m/s with a value of 2.22 m/s for RMSE. The wind direction failed the Gross Error bench of < 30° with a value of 37°. The temperature statistics were poor with TAPM showing a strong negative bias (under predicting the winds). Only between 20% and 37% of all data met the temperature bench criteria for Index of Agreement and Bias. Because TAPM did not perform well at the nearest surface station to the STP. TAPM data was only used to represent the cloud cover and cloud ceiling height as this was missing from the Hobart Airport records. TAPM data was also used to repair and replace certain missing upper air soundings from Hobart Airport.

The surface data was vertically extrapolated and the Bias values in CALMET were switched on to not use the Hobart data in the first two vertical levels.

Figure 4-2: Chart plot showing the quantity and times of Hobart Radiosonde in 2015, UTC time.
Figure 4-3: Base Map showing the CALMET meteorological modelling domain (coloured area) with terrain contours for 2015 modelling.

Wind vectors for 3 January hour 23h00 are overlaid on Figure 4-3. The meteorological conditions are stable with very light variable winds (< 1 m/s) at Blackmans Bay STP. Strong flow (~ 12m/s) on the top of Mt Wellington are normal. Katabatic winds off the elevated topography assist the nocturnal offshore flow at nights and during the winter months.
5 CONCLUSIONS

Meteorological Modelling for a full year period in 2015 has been conducted for Blackmans Bay Wastewater Treatment Plant (WWTP) in Tasmania. The meteorological data set was custom built to the Blackmans Bay site by using hourly observational data from the Bureau of Meteorology’s four nearest meteorological stations which are Dennes Point, Hobart, Kunyani and Grove. Upper air data from Hobart Airport was used to develop the upper air winds and temperature profile.

Two models, the Australian CSIROs the Air Pollution Model (TAPM) and CALMET, the diagnostic meteorological component of the CALPUFF suite of models were used to develop the meteorological data set at the STP. Both models are recognised as guideline models in Australia and New Zealand. The TAPM data at Hobart was only used to repair some of the Hobart Radiosonde soundings and to represent cloud cover as this was unavailable from Hobart Airport.

As well as preparing a one year meteorological data set, an analysis has been conducted on two historic data sets that have been used in previous air analyses. The first is a December 2004 - December 2005 AUSPLUME prepared meteorological data set from monitored data at Blackmans Bay. The second is an AUSPLUME data set derived from TAPM data for 2006 which was used in odour modelling in 2014. An evaluation of the monitored on-site data for 2005 suggests that the wind direction has been incorrectly reported in the AUSPLUME meteorological file and is likely 180 degrees out. In the 2014 modelling, the Blackmans Bay data was ruled as ‘unsuitable’ as the anemometer is located on a building and does not meet the Australian Wind monitoring standards (rather than the likely 180 degree error). However, when the wind direction data is corrected, the data appears sound and reasonable and is acceptable for use in modelling. The second data set, the 2006 AUSPLUME data set that was developed from TAPM data at the Blackmans Bay site was used in the 2014 modelling. However, an analysis showed that this data set was also flawed with westerly winds occurring almost constantly as well as through the day time during summer when onshore sea breezes occur.

Worst case dispersion conditions and potential complaints from the STP can be expected to occur under any of the following conditions:

- Any time of the day when the winds are light or from the southeast or east.
- Any time of the day when there is a major change in wind direction and wind speed.
  - This could occur mid-morning with the onset of the sea breeze. The wind direction will typically swing right around from an off shore westerly to an onshore south easterly, gradually becoming more easterly and stronger throughout the day.
  - This could occur in the early evening around sunset when the onshore sea breeze collapses along with the mixing height. The wind direction can become very variable for a time before taking up its regular night time westerly flow.
- Onset of temperature driven local upslope flows during the morning hours following sunrise. Under these conditions odour which has accumulated during the night can disperse upslope.
- Stable atmospheric conditions. Under these conditions which can occur every night, there is likely to be a surface based temperature inversion which can cause odour to be trapped allowing odour to stagnate in the stable layers close to the surface.

Development of a meteorological data set at Blackmans Bay STP is highly complex due to the large scale topographic features upwind, the effects of the Peninsula, the sea breeze and the local topography around the facility. It is a challenge to develop a meteorological data set at such a complex site. Hence it is highly recommended to re-instate a meteorological station at Blackmans Bay STP to support future works. Further, TasWater may elect to utilise the corrected 2005 on-site AUSPLUME meteorological data directly in CALPUFF to provide robustness to the 2015 modelling and to account for inter annual variability.
6 ATTACHMENT A – WIND ROSES FROM DEC 2004 – DEC 2005
BLACKMANS BAY

Wind roses from historic Blackmans Bay 2004-2005 meteorological data set. Wind roses on the left hand side are those as reported in the 2014 CEE report and the winds on the right hand side are the ones from the 2005 Ausplume data set. The reporting of the 2005 winds in the previous 2014 modelling undertaken for the site are incorrect, and data is also incorrectly written into the Ausplume met data file.

Blackmans Bay, 2005, (night hours), as reported in 2014 CEE Pty Ltd (wind blowing from)

Blackmans Bay, 2005, 01h-06h, Ausplume Met Data (Wallis)

Blackmans Bay, 2005, (day hours), CEE Pty Ltd (wind blowing from)

Blackmans Bay, 2005, 13h-18h, Ausplume Met Data (Wallis)
7 ATTACHMENT B – WIND ROSES FOR TAPM DERIVED AUSPLUME 2006 DATA AS IN 2014 MODELLING

TAPM 2006 Autumn

TAPM 2006 Winter

TAPM 2006 Spring

TAPM 2006 – Night time Hours 01h -06h

TAPM 2006 – Morning Hours 07h -12h

TAPM 2006 – Afternoon Hours 13h -18h
TAPM 2006 – Evening Hours 19h -00h
8 ATTACHMENT C – TIME OF DAY WIND ROSES AT SURFACE OBSERVATION SITES AS USED IN THE 2015, CURRENT MODELLING

Figure 8-1: Annual, Seasonal and Time of day Wind Roses from Hobart, Dennes Point, Grove and Kunyani for 2015.

The wind direction is read as the wind blowing ‘from’. West and south westerly flow is the dominant flow throughout the year at Blackmans Bay STP.

Hobart Annual | Dennes Point Annual | Grove Annual | Kunyani Annual
Hobart 01h-06h Night time

Dennes Point 01h-06h Night time

Grove 01h-06h Night time

Kunyani 01h-06h Night time

Hobart 07h-12h Morning

Dennes Point 07h-12h Morning

Grove 07h-12h Morning

Kunyani 07h-12h Morning
9 ATTACHMENT D TAPM EVALUATION

9.1 METEOROLOGICAL EVALUATION

An evaluation of the 2015 TAPM data has been conducted at the nearest observation site to the TAPM grid point. The evaluation consists of quantitative statistical comparisons of two meteorological datasets in this case the predicted 1km TAPM model output has been compared to the Dennes Point observation station for a couple of months in summer 2015. The statistical output is evaluated using benchmarks developed by Emery et al. (2001) and Tesche et al. (2001). These statistical benchmark measures are listed in Table 9-1 and the results in Table 9-2.

Table 9-1 Benchmarks for prognostic modelling evaluation

<table>
<thead>
<tr>
<th>Wind speed</th>
<th>Wind direction</th>
<th>Temperature</th>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOA</td>
<td>≥0.6</td>
<td>--</td>
<td>≥0.8</td>
</tr>
<tr>
<td>RMSE</td>
<td>≤2 m/s</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Mean Bias</td>
<td>≤±0.5 m/s</td>
<td>≤±10°</td>
<td>≤±0.5 K</td>
</tr>
<tr>
<td>Gross Error</td>
<td>--</td>
<td>≤30°</td>
<td>≤2 K</td>
</tr>
</tbody>
</table>

The TAPM gridded data was interpolated to the nearest grid cell closest to the Dennes Point observation site. The statistical measures include:

- Mean value (e.g. mean observation and mean prediction)
- Bias error (average difference, e.g. predicted – observation)
- Gross or Absolute error (average of the absolute value of the e.g. |Predicted – Observation| values)
- Root-mean-square error (RMSE), including its systematic (RMSE_s) and unsystematic (RMSE_u) components

The bias and gross errors for wind speed and direction are computed from the wind speed and wind direction values, not the U and V components of the winds.

Table 9-2. Statistical evaluation between 1km TAPM and nearest observation for wind speed (m/s), wind direction (degrees) and Temperature (K).

<table>
<thead>
<tr>
<th>Wind speed (m/s)</th>
<th>IOA</th>
<th>Bias</th>
<th>RMSE</th>
<th>RMSES/RMSE</th>
<th>Gross Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>0.85</td>
<td>2.86</td>
<td>3.97</td>
<td>0.99</td>
<td>3.29</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.21</td>
<td>-2.77</td>
<td>0.86</td>
<td>0.20</td>
<td>0.68</td>
</tr>
<tr>
<td>Mean</td>
<td>0.60</td>
<td>-0.1</td>
<td>2.22</td>
<td>0.78</td>
<td>1.81</td>
</tr>
<tr>
<td>Benchmark</td>
<td>0.6</td>
<td>0.5</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fraction meeting the benchmark</td>
<td>0.57</td>
<td>0.37</td>
<td>0.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # days</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>
### Wind direction (deg)

<table>
<thead>
<tr>
<th></th>
<th>Bias</th>
<th>Gross Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>35.04</td>
<td>106.61</td>
</tr>
<tr>
<td>Minimum</td>
<td>-49.05</td>
<td>11.08</td>
</tr>
<tr>
<td>Mean</td>
<td>3.49</td>
<td>36.91</td>
</tr>
<tr>
<td>Benchmark</td>
<td>10.00</td>
<td>30.0</td>
</tr>
<tr>
<td>Fraction meeting the benchmark</td>
<td>0.37</td>
<td>0.47</td>
</tr>
<tr>
<td>Total # days</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

### Temperature (K)

<table>
<thead>
<tr>
<th></th>
<th>IOA</th>
<th>Bias</th>
<th>Gross Error</th>
<th>RMSE</th>
<th>RMSES/RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>0.97</td>
<td>1.12</td>
<td>2.94</td>
<td>3.30</td>
<td>1.00</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.45</td>
<td>-2.94</td>
<td>0.62</td>
<td>0.94</td>
<td>0.29</td>
</tr>
<tr>
<td>Mean</td>
<td>0.72</td>
<td>-1.04</td>
<td>1.55</td>
<td>1.85</td>
<td>0.86</td>
</tr>
<tr>
<td>Benchmark</td>
<td>0.80</td>
<td>0.50</td>
<td>2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fraction meeting the benchmark</td>
<td>0.37</td>
<td>0.20</td>
<td>0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # days</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

### Specific Humidity (g/kg)

<table>
<thead>
<tr>
<th></th>
<th>IOA</th>
<th>Bias</th>
<th>Gross Error</th>
<th>RMSE</th>
<th>RMSES/RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>0.94</td>
<td>0.55</td>
<td>1.40</td>
<td>1.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.09</td>
<td>-1.4</td>
<td>0.31</td>
<td>0.4</td>
<td>0.27</td>
</tr>
<tr>
<td>Mean</td>
<td>0.51</td>
<td>-0.39</td>
<td>0.80</td>
<td>0.94</td>
<td>0.85</td>
</tr>
<tr>
<td>Benchmark</td>
<td>0.6</td>
<td>1.0</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fraction meeting the benchmark</td>
<td>0.37</td>
<td>0.80</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # days</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>
10 ATTACHMENT E METEOROLOGY AT BLACKMANS BAY

10.1 CALMET OUTPUT

Figure 10-1: CALMET stability classes at Blackmans Bay STP for the year 2015.

The plot shows the diurnal scatter of atmospheric stability by time of day. 1 means unstable conditions and 6 stable conditions. The plot below is normal and expected conditions for Blackmans Bay, Unstable conditions are normal during the day, whilst stable conditions occur at night time.
Figure 10-2: CALMET short wave radiation (W/m²) at Blackmans Bay STP for the year 2015.

The plot shows the diurnal scatter of short wave radiation by time of day. Maximum insolation occurs during the middle of the day, shortwave radiation is zero at night time.
Figure 10-3: CALMET mixing height (m) at Blackmans Bay STP for the year 2015.

The plot shows the diurnal scatter of mixing height by time of day. The maximum daily mixing height is just over 2000m but the bulk of the time the mixing height is around 1200m. This is not unexpected for a site close to the ocean.
Figure 10-4: CALMET temperature (K) at Blackmans Bay STP for the year 2015.

The plot shows the diurnal scatter of temperature by time of day. The mean temperature at Blackmans Bay STP is between 280K and 285K, i.e., around 12°C. The temperature drops below freezing (273K) in the early hours of the morning between 00h00 and 07h00. These will be winter hours. In the middle of the day the maximum temperatures are around 22°C.
Figure 10-5: CALMET wind speed (m/s) at Blackmans Bay STP for the year 2015.

The plot shows the diurnal scatter of wind speed by time of day. Blackmans Bay STP records some strong winds (>10m/s).
Figure 10-6: CALMET wind direction (deg) at Blackmans Bay STP for the year 2015.

The plot shows the diurnal scatter of wind direction by time of day. The absence of onshore easterly flow (sea breeze) is absent completely between the hours of 00h00 and 07h00 and again from approximately 21h00 to 23h00.