Appendix I

Odour assessment

Googong Township water cycle project

Environmental Assesment

November 2010

MWH

BUILDING A BETTER WORLD

GOOGONG NEW TOWN WATER RECYCLING PLANT

DRAFT ODOUR IMPACT ASSESSMENT

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REVISION SCHEDULE

REV. NO.	DATE	DESCRIPTION	PREPARED BY	REVIEWED BY	APPROVED BY
A	April 2009	Draft for Review	Georgina Gapes Zoe Moffat	Jeff Mann	Jeff Mann
B	April 2009	Draft for Review	Georgina Gapes Zoe Moffat	Jeff Mann	Jeff Mann
0	April 2009	Draft for Client Comment	Georgina Gapes Zoe Moffat	Jeff Mann	Caine Mertens
1	August 2009	Second Draft for Client Comment	Georgina Gapes Zoe Moffat	Jeff Mann	Rachel Perrin
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EXECUTIVE SUMMARY

Canberra Investment Corporation (CIC) is proposing a New Town development at Googong, located south of Queanbeyan in NSW (the 'Googong Development'). The community will contain approximately 5,500 residences, supported by retail, commercial and community services. In support of the vision of a sustainable township, the Googong Development will incorporate a Water Recycling Plant (WRP) which will receive sewage from the Googong Development sewerage system and treat it to a standard suitable for re-use. The development of this infrastructure, along with a number of reservoirs, sewage pumping stations (pumping stations) and other key integrated water cycle management measures, forms part of the Googong Water Cycle Project.

The development of the WRP has been assessed in this report on the basis that it will occur in two stages as required by the developing neighbourhoods. Stage 1 is to cater for the wastewater flows which will occur in the first 5 to 7 years of the Googong Development, and Stage 2 is to cater for the ultimate flows associated with the Googong Development. These stages mirror the needs of Part 3A of the Googong Water Cycle Project and project applications.

The WRP and associated pumping stations have the potential to be odour sources which could impact on neighbours. In order to evaluate the potential odour impact of the proposed Googong WRP and the initial pumping stations, and determine the requirements for odour capture and control, computer based odour dispersion modelling of the potential odour sources on site has been undertaken using the dispersion models AUSPLUME and CALPUFF in accordance with the methods set by the NSW Department Of Environment, Climate Change and Water (the DECCW).This Odour Impact Assessment report is intended for submission to the DECCW for the review and assessment of compliance with the impact assessment criteria for complex mixtures of odorous air pollutants. The objectives of this report are therefore to provide:

1. An assessment of the predicted odour impacts from odour releases at the proposed initial pumping stations and the Googong WRP at Stage 1 (first 5 to 7 years of development) and Stage 2 (ultimate development). This involves undertaking:

    - Dispersion modelling of two pumping stations located along the proposed sewer network for Stage 1 of development;

    - Dispersion modelling of the predicted odour impact from the proposed Googong WRP for Stage 1 of development, without odour control ("baseline" impact without odour control measures employed); and

    - Dispersion modelling of the predicted odour impact from the proposed Googong WRP for Stage 1 and Stage 2 of development with various odour control measures implemented (to determine the degree of odour control required to meet the DECCW odour impact criteria).

2. Guidance on the means by which such odour impacts might be mitigated through the implementation of odour extraction and control facilities installed at the proposed Googong WRP (including determining the process units requiring odour control covers, and the nature of any odour control facility required, including its stack height and odour discharge concentration limit), in combination with the implementation of an appropriate urban design solution.

Results of the dispersion modelling of the proposed Googong WRP and the initial pumping stations have shown that odour control measures are required for Stage 1 and Stage 2 of development in order for the pumping stations and the WRP to achieve compliance with the DECCW urban area odour impact criteria of 2 odour units (ou). The dispersion modelling results have also been used to inform the urban design process.

Odour impact dispersion modelling undertaken for the pumping stations shows that the pumping stations, when fitted with activated carbon odour control units (a common technology for this type of application), do not exceed the urban area odour impact criteria.

Odour impact dispersion modelling undertaken for Stage 1 of the WRP shows that odour control measures would need to be employed to meet the DECCW urban area odour impact criteria of 2 ou. Incremental scenario modelling (modelling of combinations of odour emission sources at the WRP being subject to odour control) reveals that the following odour sources at the WRP would require odour control:

- Inlet works: receiving chamber; screening 1 (channel, coarse and fine screens, screening bins); vortex grit chamber and channels; pre-distribution chamber
- Bioreactor 1: distribution chamber 1; first anoxic zone; aerobic zone; deaeration zone; second anoxic zone; membrane bioreactor
- Rotary drum thickener
- Aerobic digester

An odour control facility with the operating parameters shown below would be required to achieve compliance with the DECCW odour impact criteria for Stage 1:

- An airflow of 9,030 m^3/hr
- A stack height of 8 m
- A stack efflux velocity of 15.8 m/s
- A stack odour emission concentration of 500 ou

Odour impact dispersion modelling undertaken for Stage 2 of the WRP shows that odour control measures would need to be employed to meet the DECCW urban area odour impact criteria of 2 ou. Incremental scenario modelling (modelling of combinations of odour emission sources being subject to odour control) reveals that the following odour sources at the WRP would require odour control:

- Inlet works: receiving chamber; screening 1 and screening 2 (channel, coarse and fine screens, screening bins); vortex grit chamber and channels; pre-distribution chamber
- Bioreactors 1 - 4: distribution chambers 1 and 2; first anoxic zones; aerobic zones; deaeration zones; second anoxic zones; membrane bioreactors
- Rotary drum thickener
- Aerobic digester

An odour control facility with the operating parameters shown below would be required to achieve the odour impacts shown in Section 5.1.3 for Stage 2 (a small area of odour impact to the north of the WRP in land which may meet the NSW DECCW requirements depending on land use type):

- An airflow of 21,630 m^3/hr
- A stack height of 8 m

- A stack efflux velocity of 15.6 m/s
- A stack odour emission concentration of 500 ou

The wastewater treatment process design and therefore the odour control parameters for Stages 1 and 2 of the WRP are likely to be optimised in the WRP concept design phase. It is recommended that, once the concept designs have been finalised, the odour dispersion modelling be revisited to ensure that compliance with the DECCW odour impact criteria can be met.

The urban design process is also being informed by the odour impact dispersion modelling. The NSW DECCW sets odour impact criteria based on the size of the potentially effected population, with higher population density areas having a lower odour impact criteria value than lower density rural and semi-rural areas.

All air pollution dispersion modelling is an approximation, so some caution needs to be applied to the use of predicted odour impacts. The urban design process, cognisant of the need for caution, has incorporated the use of lower population density planning principles in the areas surrounding the WRP, even though the dispersion modelling shows that higher density populations may be suitable in the areas surrounding the WRP after the implementation of odour control measures.

The dispersion modelling has been undertaken using the best available data at the time, however, as the WRP has not been constructed yet and the WRP site is undeveloped at this stage, odour emission data from other similar sites with similar processes have been used, and historical meteorological data from the Canberra area or generated from synoptic data have been used. The use of non-site specific odour emission and meteorological data in the modelling means that, under the assessment process specified by the DECCW, the most conservative approach to assessing dispersion model results needs to be taken. If site specific data is used, a less conservative approach can be adopted.

The dispersion modelling results show that, if the less conservative assessment approach is used, the WRP meets the urban area odour impact criteria for both Stage 1 and Stage 2 of development. If the most conservative approach is taken, Stage 1 of the WRP development meets the urban area odour impact criteria, but Stage 2 of the WRP development exceeds the urban odour impact criteria in a small area to the northeast of the proposed WRP site. The exceedance for Stage 2 can be addressed in two ways.

The first way is to plan for land use adjacent to the WRP that does not have urban population densities. The level of predicted odour impact for Stage 2 at the most conservative level of assessment is such that other land uses adjacent to the WRP with lower population densities could be undertaken. It is our understanding that the urban design process is investigating this approach.

The second way is to undertake collection of site specific meteorological and odour emission data and use this in the dispersion modelling. Given the timeframes involved in development of the Googong WRP, it should be possible to install a meteorological data collection station at the proposed site to collect sufficient site specific data for use in dispersion modelling. The development stages of Googong New Town and the WRP within it will allow for site specific odour data collection. It is understood that the residential developments associated with Stage 1 of the WRP will initially occur furthest from the WRP and then be developed closer to the WRP over time. Prior to the residential areas becoming “close” to the WRP, the WRP should be in operation, albeit under partial flow regimes. While these partial flow regimes could result in higher odour strengths being measured at the WRP (the lower flows could result in more odorous sewage until design flows are achieved), measurement of these odours and their use in future dispersion modelling would allow for the less conservative level of odour impact assessment to be used. The potential for using areas closer to the WRP for urban use could then be re-evaluated.

Based upon the dispersion modelling undertaken to date, the predicted odour impacts from the initial pump stations and the WRP at initial and final configurations, when combined with appropriate land use, would comply with the NSW DECCW odour impact criteria of 2 ou. It is recommended that the odour impact assessment be undertaken again once the designs for the WRP have been further developed to ensure compliance can still be shown.

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1. INTRODUCTION

1.1 BACKGROUND

Canberra Investment Corporation (CIC) is proposing a new residential community development at Googong, located south of Queanbeyan in NSW (the 'Googong Development'). The community will contain approximately 5,500 residences, supported by retail, commercial and community services. In support of the vision of a sustainable township, the Googong Development will incorporate a Water Recycling Plant (WRP) which will receive sewage from the Googong Development sewerage system and treat it to a standard suitable for re-use. The development of this infrastructure, along with a number of reservoirs, sewage pumping stations (pumping stations) and other key integrated water cycle management measures, forms part of the Googong Water Cycle Project. The Googong Water Cycle Project is subject to Part 3A approvals. This odour impact assessment report has been prepared in support of the Part 3A approval process.

The Googong development is to be undertaken in a number of stages or neighbourhoods. The first neighbourhood to be developed, and the most significant in terms of its locality to the proposed WRP, is the eastern portion of Neighbourhood 1A (hereafter referred to as Neighbourhood 1A). Adjacent to the plant, and to the south of Googong Dam Road, Neighbourhood 1A is to be developed over a period of 5-7 years. The remaining neighbourhoods are planned to be developed over a period of 25 years.

Due to the nature of the Googong Development, and in order to minimise initial capital cost, it has been proposed that the WRP also has staged construction to reflect the residential development that contributes to incoming flows to the WRP. For the purposes of this odour impact assessment report, two development stages have been considered, although there will be interim development stages for the actual project

The two stages considered in this report are:

- **Stage 1** - Neighbourhood 1A has been developed and the WRP is configured to receive these flows.
- **Stage 2** - Additional neighbourhoods have been developed and the WRP is at its final (ultimate) configuration and flows.

A previous study identified the area within which wastewater infrastructure needed to be considered. Figure 1-1 is taken from that study and depicts the Googong wastewater system study area with Neighbourhood 1A of the residential development shaded in blue. The remaining neighbourhoods, Neighbourhood 1B and Neighbourhoods 2-5, are also shown. The location of the WRP is highlighted in orange, the main gravity sewers carrying wastewater to the wastewater pumping stations are shown as dark orange with arrows, and the cross symbols show the locations of the pumping stations (see below). At the time of the odour impact assessment, the location of Pump Station 1 (PS1 on the map) has been fixed in the location shown. The location of Pump Station 2 (PS2) is approximate within, say, 50 metres and dependent upon final urban area layout.

In order to transport wastewater to the WRP, a wastewater network will need to be installed. Due to the proposed location of the WRP and the sloping topography of the Googong Development area, it will be necessary to install a number of pumping stations to raise the wastewater between sections of the sewer that flow under gravity. These pumping stations may be located in residential areas, and therefore the potential for odorous emissions to impact on neighbours also needed to be assessed.

Section 129 of *The Protection of the Environment Operations Act 1997* (the POEO Act)[(1)], and its subordinate legislation, prohibits facilities from emitting odours which can pass beyond the boundary of the facility and create offence to neighbours (often referred to as sensitive receptors) of the facility. As part of the planning stage of the Googong WRP and initial pump stations, odour dispersion modelling of the proposed plant and pump stations has been undertaken to determine the predicted odour impact of this infrastructure on potential surrounding odour-sensitive receptors and demonstrate compliance with regulatory impact assessment requirements.

Odour extraction and control facilities have been investigated for inclusion in the design of the WRP and the pump stations. This Odour Impact Assessment Report presents the findings and recommendations for the proposed odour control strategy, and discusses the impacts of these on potential land use options surrounding the WRP.

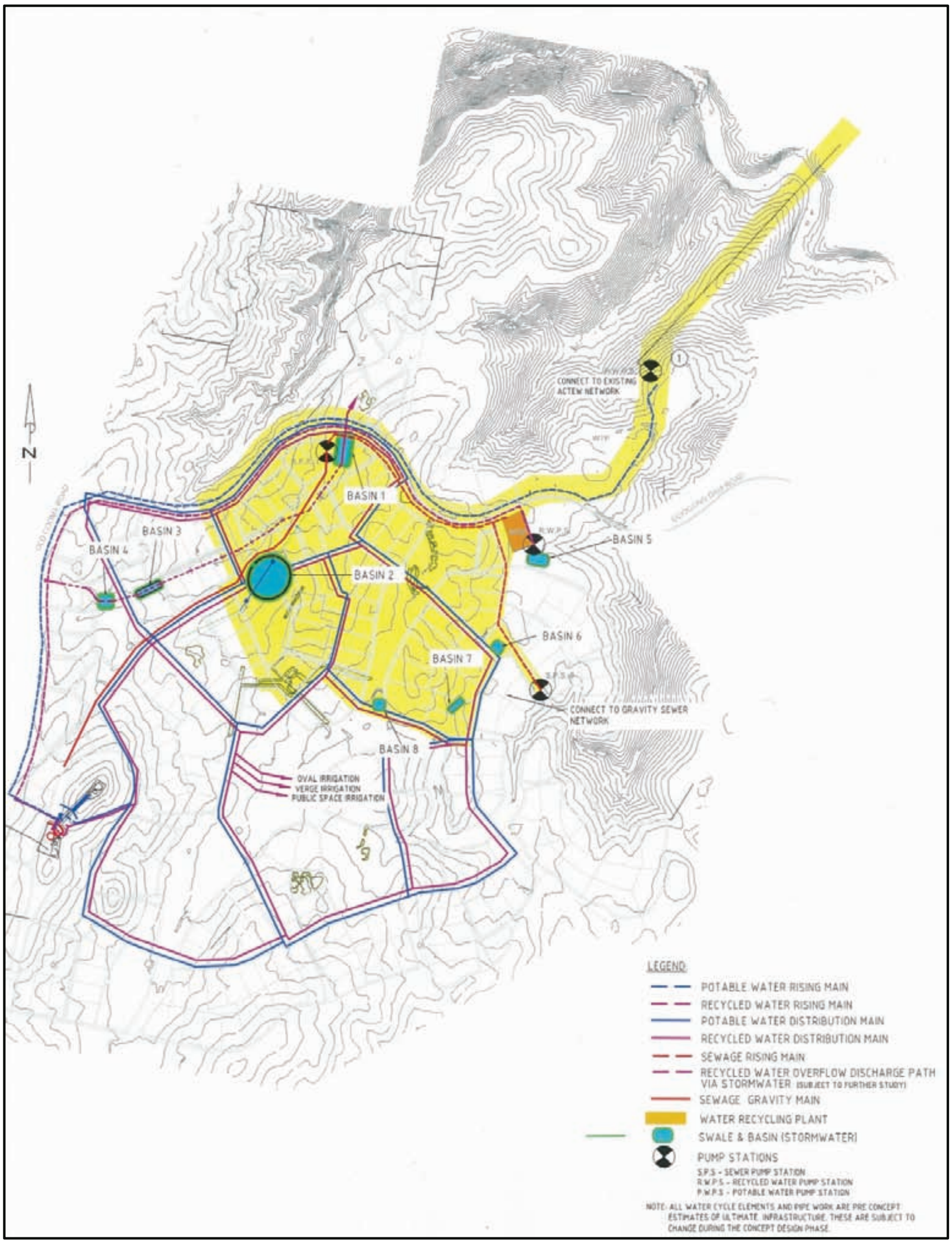


Figure 1-1: Googong WRC System Study Area showing Neighbourhood 1A (in Yellow)

1.2 SCOPE OF WORK

In order to evaluate the odour impact of the proposed Googong WRP and initial pumping stations, and determine the requirements for odour capture and control, atmospheric dispersion modelling of the sites has been undertaken using the dispersion models AUSPLUME and CALPUFF, specifically:

- Dispersion modelling of two pumping stations located along the proposed sewer network for Stage 1 of development;
- Dispersion modelling of the predicted odour impact from the proposed Googong WRP for Stage 1 of development, without and with odour control; and
- Dispersion modelling of the predicted odour impact from the proposed Googong WRP for Stage 2 (ultimate) development with various odour control measures implemented.

A number of models, reflecting various odour emission control scenarios, have been completed as part of this assessment to provide CIC with a detailed understanding of the potential odour impacts of the proposed WRP. When the Googong Development has been completed and the WRP fully developed to treat these flows, the potential for odour impacts from the WRP will be different than for when the WRP caters for Neighbourhood 1A flows alone. There are also likely to be additional pumping stations installed when the full development has occurred. While this report is in support of CIC's application for the initial stages of the Googong Development, it also considers the potential odour impact of the WRP when all neighbourhoods have been developed.

Odour emissions associated with the proposed operations at the Googong WRP have been modelled to assess compliance with NSW Department of Environment, Climate Change and Water (the DECCW) ground-level impact criteria for complex mixtures of odorous air pollutants. Based on the extent of the odour footprint of uncontrolled odour emissions from Stage 1 and Stage 2 development of the WRP in relation to the regulatory criteria, the requirements for odour capture and control have then been assessed.

This Odour Impact Assessment report is therefore intended for submission to regulatory authorities for the review and assessment of compliance with odour impact criteria as set down by the DECCW. In view of this, the objectives of this report are to provide:

1. An assessment of the predicted odour impacts from odour releases at:

   a. the proposed initial pumping stations at Stage 1 development; and

   b. the Googong WRP at Stage 1 and Stage 2 (ultimate) development,

   and the degree of compliance of these predicted odour impacts with the DECCW odour impact criteria.

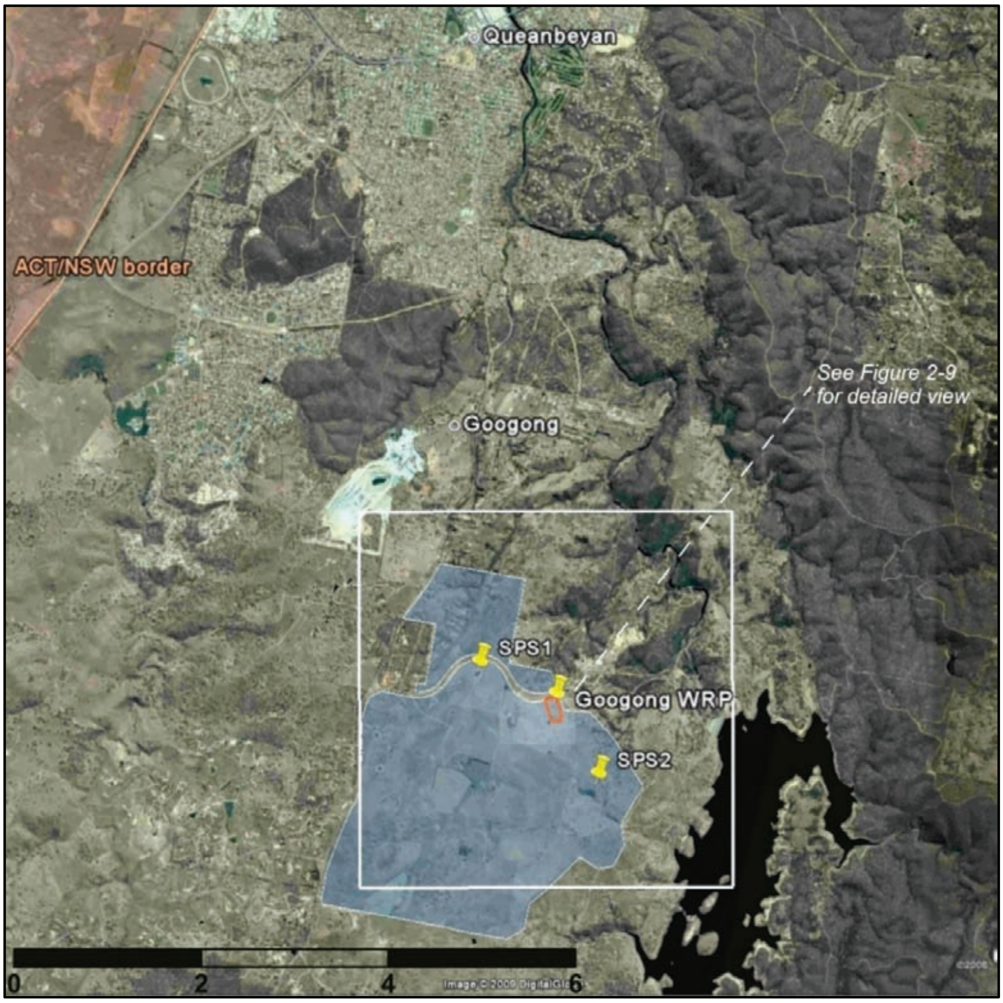
2. Guidance on the means by which such odour impacts might be mitigated as required through the implementation of odour extraction and control facilities installed at the proposed pumping stations and at the Googong WRP (including determining the process units requiring odour control and the nature of any odour control facility required including its stack height and odour discharge concentration limit).

3. Discussion on the types of appropriate land use surrounding the WRP.

1.3 DESCRIPTION OF THE PROPOSED SITE

The proposed site for the Googong WRP is approximately 8 km south of Queanbeyan, NSW, to the north west of the Googong Reservoir. The proposed WRP site boundary (outlined in orange in Figure 1-2) is to be located in the north east sector of the Googong Development area (shaded in blue). The 4 km x 4 km dispersion modelling domain used in this Odour Impact Assessment is outlined in white. For a detailed view of the WRP site, see Figure 2-9. Please note that Figure 2-9 shows one of several possible land use arrangements surrounding the WRP and is shown for information only.

For the purposes of the odour dispersion modelling, a summary of the major process units at the WRP for Stage 1 and Stage 2 is shown in Table 1-1 . A site layout drawing containing the proposed process units for stages 1 and 2 is provided in Appendix A, and a process flow diagram showing the wastewater treatment trains is provided in Appendix C. It should be noted that the design of the treatment plant is preliminary and may be subject to change, and therefore the results of the modelling should also be considered preliminary until the assumptions on the treatment processes to be employed are confirmed.



Source: Google Earth © 2008 Version 4.3 and overlays provided by CIC.

Figure 1-2: Location of Modelling Domain (white box) containing Googong WRP

The wet weather capacity of the Googong WRP will be approximately 9.2 ML/day with an Average Dry Weather Flow (ADWF) of 3.5 ML/day being treated. The proposed design for the Googong WRP is to incorporate:

- coarse (3mm) and fine (1mm) screening
- grit removal by vortex grit chamber
- chemical dosing for phosphorus removal
- a 4-stage Bardenpho process (activated sludge process)
- a proprietary modular membrane bioreactor (MBR) system consisting of a suspended growth biological reactor coupled to a submerged ultrafiltration system
- ultra violet (UV) disinfection and chlorination
- sludge thickening, aerobic digestion, sludge dewatering and transport off site.

As shown in Table 1-1, one secondary treatment process train (bioreactors) will be required to treat incoming sewage for the first 7 years of development (Stage 1). To meet the ultimate design requirements (Stage 2), an additional screening unit, UV module and 3 additional secondary treatment trains will be required.

Table 1-1: Googong WRP Staged Development

PROCESS UNIT	TOTAL INSTALLED AT COMPLETION OF STAGE 1 (YEAR 1-7)	TOTAL INSTALLED AT COMPLETION OF STAGE 2 (YEAR 25)
Inlet Works:		
Receiving chamber	1	1
Screening (channel, fine and coarse screens, screening bins)	1	2
Grit removal (vortex grit chamber)	1	1
Pre-distribution chamber	1	1
Bioreactors:		
Distribution chamber	1	2
Bioreactor unit (conventional activated sludge with MBR)	1	4
Miscellaneous:		
UV modules	1	2
Chlorination contact tank	1	1
Foul water tank	1	1
Chemical storage	1	1
Odour control facility	1	1 (capacity increased from Stage 1)
Biosolids Area:		
Rotary drum thickener	1	1
Aerobic digester	1	1
Sludge dewatering (centrifuge)	1	1
Truck outloading	1	1

Source: Adapted from MWH (2009) [3]

The initially proposed WRP site layout is shown in Appendix A. In order to provide a conservative approach during the odour modelling, the location of the inlet works ('screenings'), aerobic digester and sludge handling process units were swapped with the location of the administration building, switch room and blower/compressor room shown in Appendix A. Since the Googong WRP site plan provided is only preliminary, it was deemed necessary to position the more odorous process units close to the western boundary of the site, nearest to the proposed residential development. The site layout modelled (included in Appendix B) is therefore different to that shown in Appendix A.

Consideration should be given to the "odour potential" for wastewater arriving at the WRP during staged development. While the WRP is planned to be amplified over time to cater for increasing flows, it is unusual for the wastewater transport system to undergo such amplification. The sewers and pump stations are normally installed sized to treat final flows. In the early stages of development, less than full flows of wastewater flowing through a transport system sized for full flows can result in extended wastewater residence times in the transport network. As a general rule, the "older" the wastewater, the greater the potential for the wastewater to become odorous. Within this odour impact assessment, this increased odour potential for wastewater arriving at the WRP has been addressed by:

- For the pump stations, CIC have committed to fitting the pump stations with activated carbon odour control. Suitably sized units will allow for control of odours from the wastewater irrespective of its age
- For the WRP, apart from the "base case" for Stage 1 where no odour control has been assumed, all other modelling scenarios allow for odour control to be employed on the inlet works of the WRP.

2. ODOUR ASSESSMENT METHODOLOGY

The Odour Impact Assessment of Googong WRP and the pumping stations for Stage 1 has used the CALPUFF dispersion model, in accordance with the requirements of the DECCW's *Approved Methods For The Modelling And Assessment Of Air Pollutants*(4) (The Methods).

2.1 IMPACT ASSESSMENT CRITERIA

The Methods have two different conditions for the assessment of odour impacts, depending on the quality of input data used in the model. If site-specific odour emission and meteorological data are used, then the less stringent criteria of the 99th percentile of the predicted odour concentrations can be used for odour impact assessment. If non-site-specific data are used, then the 100th percentile or maximum concentrations must be reported.

For the odour assessment undertaken for the Googong WRP, odour emissions have been estimated using the MWH Odour Emissions Database, based upon olfactometry samples from similar sites with similar wastewater treatment processes and operating conditions. Hourly meteorological data used in the model have been generated using the CSIRO's TAPM model, a meteorological model which uses synoptic-scale meteorology and regional terrain data to generate a 3-dimensional windfield data set. Although this could be considered to be representative of conditions at the site, observational meteorological data from an on-site weather station is preferable, as is site-specific odour emission data. For these reasons, and since the WRP design considered in the modelling is also preliminary, both the 99th and 100th percentiles have been reported to show the degree of uncertainty associated with the dispersion modelling at this stage.

The DECCW bases its odour impact criteria on the likelihood of an odour sensitive person being resident within a given population i.e. the larger the number of people potentially impacted by the odour, the greater the possibility that someone within that group of people will be sensitive to the odour. The DECCW uses a sliding scale of odour impact criteria based on the density of the potentially effected population as shown in Table 2-1.

Table 2-1: Impact Assessment Criteria for Googong WRP

POPULATION DENSITY OF AFFECTED COMMUNITY (PERSONS PER km^2)	IMPACT ASSESSMENT CRITERIA (ODOUR UNITS)
Urban areas (≥~ 2000) and/ or schools and hospitals	2.0
~ 500	3.0
~ 125	4.0
~ 30	5.0
~ 10	6.0
Single residence (≤ ~ 2)	7.0

Source: Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DECC 2005)

The impact assessment criterion of 2 odour units (ou) has been used in the odour assessment of the Stage 1 and Stage 2 configurations for the Googong WRP. This allows for the presence of residential, commercial and recreational areas planned for the new town development (refer Section 2.4.3 of this report). This is considered to be "worst case" in terms of land use planning surrounding the WRP, and as detailed elsewhere in this report, land use assuming less than urban densities is being considered for areas surrounding the WRP.

2.2 PEAK TO MEAN RATIOS

The DECCW require that odour impact assessments be undertaken for the nose response time (taken to be one second). However, CALPUFF is not capable of rendering predictions for a one second averaging period. The Methods therefore incorporate 'Peak to Mean ratios', which, when applied to the one hour averaging period predictions of CALPUFF, allow the predictions to be interpreted as one second averaging period values.

The peak to mean ratios shown in Table 2-2 below were applied to the odour emission rates in the Googong WRP dispersion modelling. The peak to mean ratios have been varied by atmospheric stability class (based on the work of Pasquill and Gifford), depending on the degree of vertical mixing that occurs in the atmosphere. This mixing is driven by wind passing over obstructions and the heating of the ground by the sun, and is categorised in Stability Classes A – F. See Section 2.4.1.2 for a more detailed explanation.

Near-field receptors have been assumed in the selection of the peak to mean ratios, due to the close proximity of sensitive receptors, as shown in Figure 2-9. According to the Methods, the near field is the zone where source structures (such as buildings) directly affect the dispersion of odour by interfering with the flow of winds over or around the odour source. The near field is typically 10 times the largest odour source dimension, either height or width.

Table 2-2: Peak to Mean Ratios* Applied to Odour Emission Rates

SOURCE TYPE	PASQUILL-GIFFORD STABILITY CLASS	
	A, B, C, D	E, F
Area (A)	2.5	2.3
Wake-Affected Point (WAP)	2.3	2.3

* Ratio of peak 1-second average concentrations to mean 1-hour average concentrations

Area sources are odour emission sources such as tanks, ponds and stockpiles; where ambient conditions of wind and temperature determine the rate of odour emission from a source.

Point sources are odour emission sources such as stacks or vents, where there is a relatively high velocity of air through a relatively small orifice. A wake-affected point is where the discharge of the point source is within the zone of disturbed air that is created as the wind passes around or over nearby structures such as building or trees.

2.3 DISPERSION MODELLING UNDERTAKEN

Models representing the Googong WRP at Stage 1 and Stage 2 of development and the Stage 1 pumping stations have been produced using the AUSPLUME[(5)] dispersion model as an options screening tool, and the CALPUFF[(6)] dispersion model has been used for the assessment and reporting of the baseline and final variations of the odour control models. Both AUSPLUME and CALPUFF require data on the meteorological conditions which apply to the site, the magnitude and variability of emissions which occur at the site, and the terrain and land use for the region containing the emission sources. Information on the data used in the modelling is included in Section 2.4.

The following models have been produced using CALPUFF:

1. **Pumping Station Stage 1 Odour Control Models:** a 2-dimensional windfield model of each of the proposed pumping stations for Stage 1 of development, SPS1 and SPS2, showing the predicted odour impacts with odour control installed.

2. **Googong WRP Stage 1 Baseline Model:** a 3-dimensional windfield model of the Googong WRP configuration for Stage 1 of development, showing the predicted odour impact without odour control.

3. **Googong WRP Stage 1 Odour Control Model:** a 3-dimensional windfield model of the odour control scenario that demonstrates the degree of compliance with the DECCW odour impact criteria for Stage 1.

4. **Googong WRP Stage 2 Odour Control Model:** a 3-dimensional windfield model of the odour control scenario that demonstrates the degree of compliance with the DECCW odour impact criteria for Stage 2. This model is built upon the Stage 1 odour control model and includes the additional process units at the WRP for the Stage 2 development.

Odour dispersion modelling inputs and results specific to the Googong WRP Stage 1 baseline and Stages 1 and 2 odour control scenarios are included in Sections 4.1, 4.2 and 5.1 respectively. Inputs and results for the pumping station odour modelling are presented in Section 3. It should again be noted that the modelling results for the WRP are considered preliminary due to the use of estimated odour emission data, the use of synthetic meteorological data, and the preliminary plant design and layout. It is recommended that the dispersion models are validated at a later stage in the design.

2.3.1 MODEL EVALUATION

AUSPLUME is a Gaussian plume model, based on the assumption that cross-sections through plumes from emission sources have a Gaussian (or normal) distribution of concentration across the plume, and that the concentration of the plume becomes less the further downwind of the source. AUSPLUME is also a steady-state model, which assumes the atmosphere is in a state of uniform flow hour by hour, and wind velocity is a function of height alone and does not vary with direction. The mathematical basis of AUSPLUME is the Victorian EPA's Plume Calculation Procedure [(8)], which is an extension of the ISC model [(9)].

CALPUFF is an advanced multi-layer, non-steady-state puff dispersion model that can simulate the effects of time and space varying meteorological conditions on pollutant transport, chemical transformation and removal. It consists of three main components and a set of preprocessing and post processing programs. The main components of the modelling system are 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 are also processed and introduced into the wind field.

According to The Methods, CALPUFF is the preferred model over AUSPLUME in conditions such as extensive periods of calm or very light winds, coastal environments (where coastal fumigation can occur), temperature inversions, or complex terrain. On the basis that Googong is located in a region of undulating terrain, experiencing low wind speed conditions and the likelihood of nocturnal temperature inversions, CALPUFF has been used for the baseline and final options modelling for this Odour Impact Assessment.

2.4 MODEL INPUTS

Inputs common to both the Stage 1 and Stage 2 modelling scenarios, including meteorological data and terrain elevations are presented in this section. The locations of odour-sensitive receptors, for example residential areas planned for each stage of the Googong Development, are also addressed.

The model parameters used in the odour dispersion modelling of the Googong WRP are outlined in the list below, and are applicable to both of the modelling scenarios. They are:

- An AUSPLUME meteorological data file containing TAPM-generated, 2-Dimensional prognostic meteorological data for screening model runs: wind speed, direction, ambient temperature, atmospheric stability class and mixing depth;
- A CALMET meteorological data file containing TAPM-generated, 3-Dimensional prognostic meteorological data for CALPUFF model runs: data for 5 surface stations and 1 upper air station have been used in this data set;
- A terrain data file containing 3 dimensional terrain data at 100 m spacing, with terrain effects modelled using the Egan Half Height approach (refer Section 2.4.2 for an explanation of the Egan Half Height approach). SRTM3 (Shuttle Radar Topographic Mission) global terrain data at 90 m resolution was also used;
- USGS (United States Geological Survey) land use and land cover data for the region;
- A 4 km by 4 km Cartesian receptor grid with 100 m grid spacing;
- Odour source details such as locations, dimensions and emission rates. Emission rates specified in ou.m/s were used for area sources (specific odour emission rate (SOER)) and concentrations in odour units (ou) and airflow rates for point sources; and
- A one second averaging period using the DECCW approved emission rate adjustment methodology (Peak to Mean ratios).

Background odour data, such as odour emissions originating from nearby industrial or commercial operations, have not been included in the modelling. The potential for background odour to be present, except for “country air” odour, are considered negligible in the region surrounding the proposed Googong WRP (or in any activities known to be planned for that region in the future).

2.4.1 METEOROLOGICAL DATA

AUSPLUME and CALPUFF require meteorological data as input to the dispersion model. Since site-specific meteorological data could not be obtained for the Googong WRP site (given that the WRP has not yet been built), prognostic meteorological data has been used to represent odour transport and dispersion conditions of the region containing the WRP.

The DECCW Methods state that in the case where suitable site-specific or site-representative meteorological data is not available, prognostic meteorological models may be used. The Air Pollution Model[7] (TAPM) is a three dimensional prognostic meteorological and dispersion modelling system developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The software uses databases of terrain, vegetation, soil type, sea surface temperature and synoptic-scale meteorological analyses for Australia.

TAPM generated meteorological data were used in the CALPUFF dispersion modelling based on synoptic data for the year 2006 (a recent year of synoptic analysis provided by CSIRO). The year of meteorological data used is not a significant factor in the modelling but did allow comparison to actual meteorological data collected in Canberra (refer Section 2.4.1.1). Five nested grids were used (30 km, 10 km, 3 km, 1 km, 0.3 km) to derive the meteorological data set. The meteorological parameters used in TAPM and CALMET as input in the dispersion models are listed in Table 2-3. An AUSPLUME compatible meteorological dataset was extracted from TAPM and used in the screening level odour dispersion models for the Googong WRP.

Table 2-3: Meteorological Parameters used for the Dispersion Modelling

TAPM (v4.0)	
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km, 0.3 km)
Year of analysis	2006
Centre of analysis	Googong (702,000E; 6076,000N)
CALMET (v6.326)	
Meteorological grid domain	6 km x 7 km
Meteorological grid resolution	0.1 km
Surface meteorological stations	Data extracted from the TAPM simulation (from the innermost grid 0.3 km) at 5 points surrounding the proposed WRP site to give 5 surface stations
Upper air meteorological stations	Data extracted from the TAPM simulation for 1 upper air station

In the following subsections, a review of the key aspects of the meteorological data has been completed to identify elements which may influence the odour dispersion modelling for the proposed Googong WRP.

2.4.1.1 WIND SPEED AND DIRECTION

A wind rose (a graphical representation of the frequency of wind speeds and directions which occur in the meteorological data used) has been produced from the AUSPLUME meteorological data file containing TAPM-generated, 2-Dimensional meteorological data and is shown in Figure 2-1. In the wind rose, 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.

In the wind rose, the meteorological data generated by TAPM shows that low wind speeds, which are the winds which contribute most to odour impacts, generally occur in all directions throughout the year, however with a significant bias from the south-east and north-north west. Higher wind speeds also occur from the south-east and north-west.

Actual observational data was obtained from an automatic weather station in Canberra, suitable for use in AUSPLUME. Wind speed and direction frequency for this data set are shown in the wind rose in Figure 2-2. In order to assess the suitability of the TAPM-generated meteorological file against this observational data, a simple AUSPLUME dispersion model was set up, containing a single area source. The model was run firstly using observational meteorological data from Canberra and then with the TAPM generated data. In comparing the results from the two model runs, it was found that there was no significant difference in ground-level odour concentrations between the two model runs, indicating that the low wind speed data in the TAPM-generated dataset did not vary greatly to the low wind speed data in the observational dataset. Since low wind speeds contribute most to odour impacts, it was concluded that the TAPM generated meteorological data was suitable for use in modelling the Googong WRP.

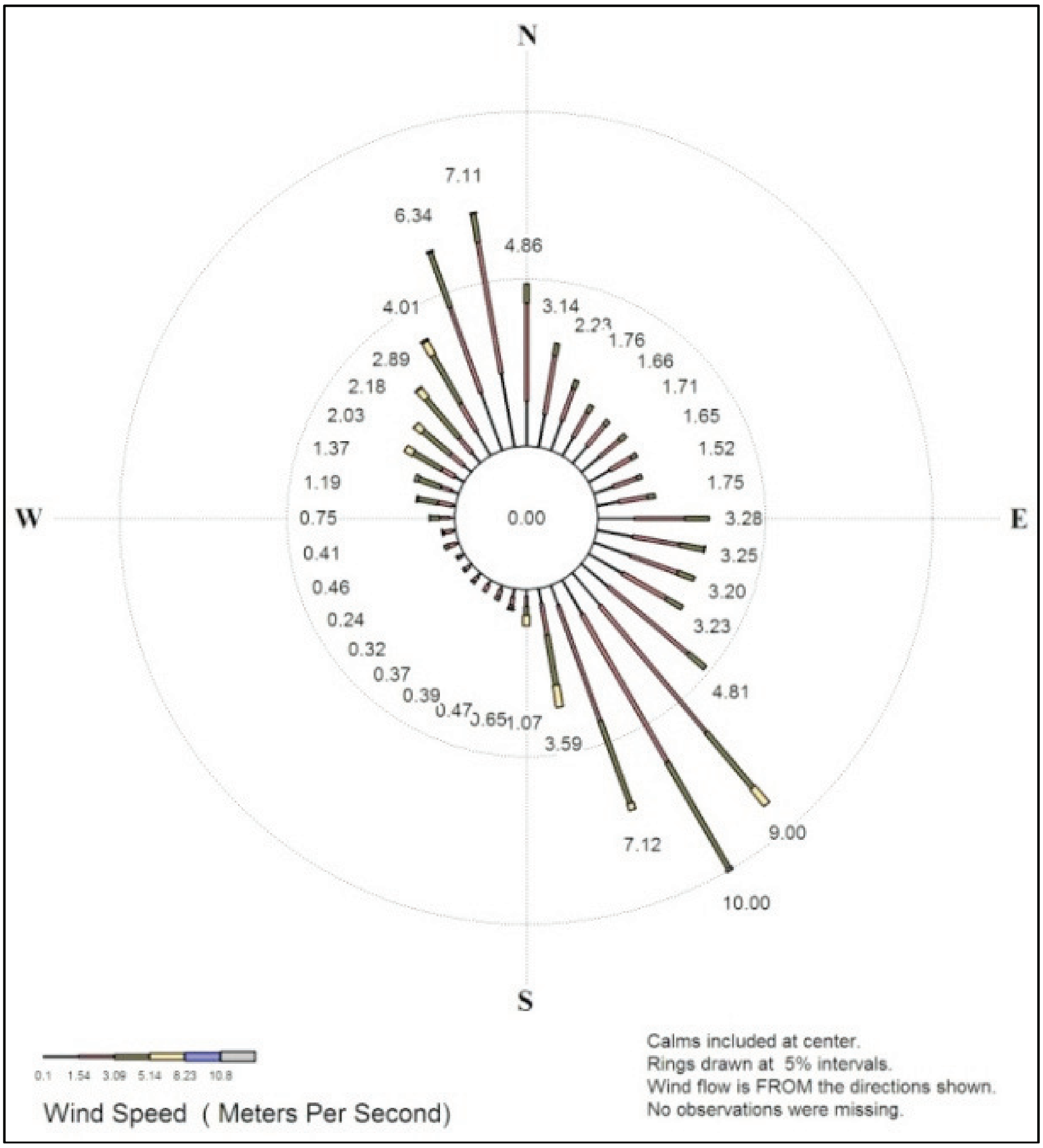


Figure 2-1: Wind Rose of Googong TAPM Generated Meteorological Data used in the AUSPLUME Modelling

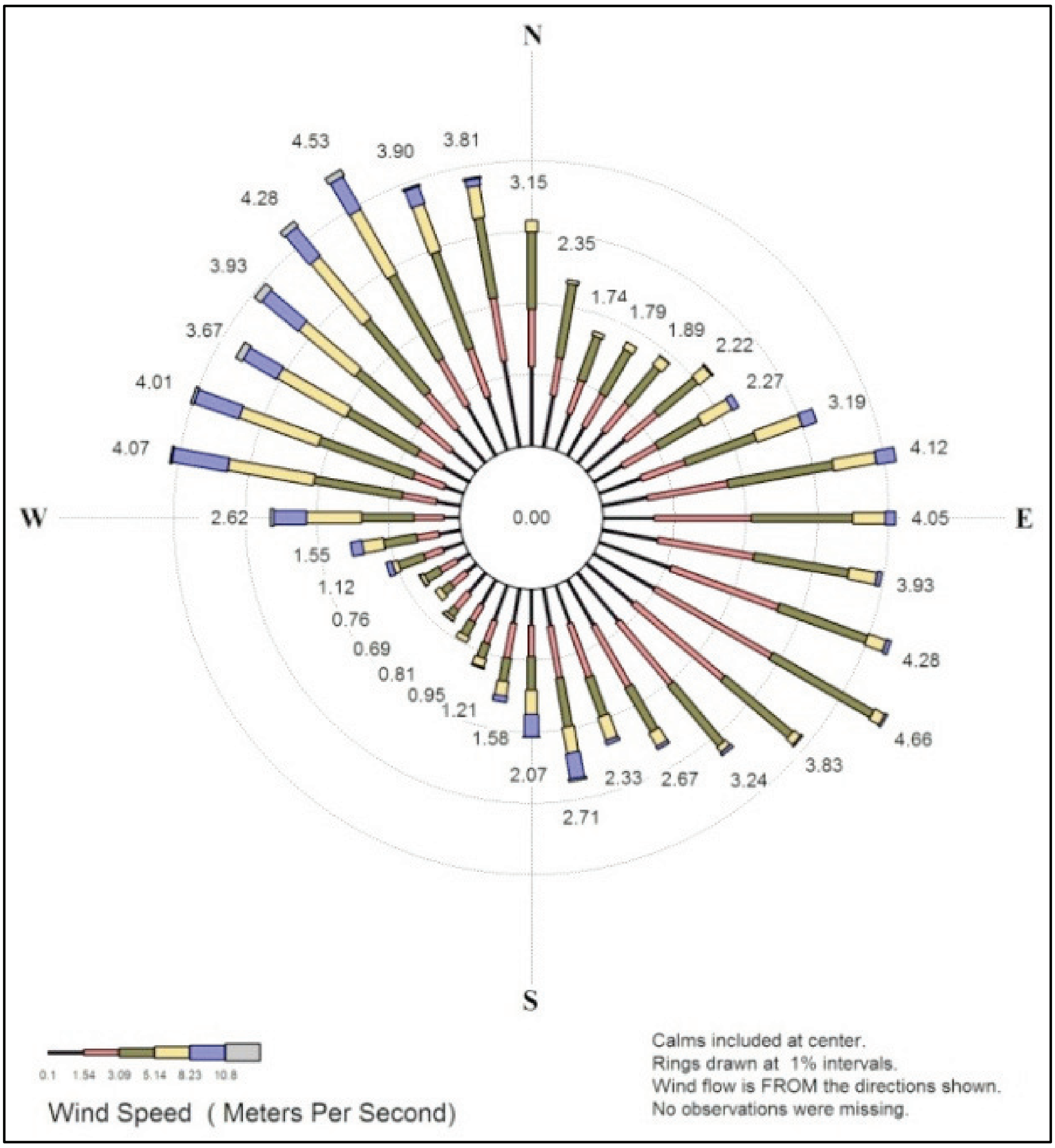


Figure 2-2: Wind Rose of Canberra Observational Meteorological Data used for Validation Purposes

2.4.1.2 ATMOSPHERIC STABILITY

In dispersion modelling, the degree of vertical mixing that occurs in the atmosphere (driven by wind passing over obstructions and the heating of the ground by the sun) is categorised into Stability Classes, namely Classes A to F. Classes A and B describe unstable conditions (conditions which promote dispersion of emissions due to the high degree of vertical mixing), classes E and F describe stable conditions (conditions which limit the dispersion of emissions due to the low degree of vertical mixing) and Classes C and D describe neutral conditions (conditions which are neither dominantly stable or unstable).

As shown in Table 2-4, the TAPM-generated meteorological data file shows that the conditions over the Googong WRP site are predicted to be unstable for an average of 17% of recorded hours in the year and neutral for 44% of hours. Stable conditions (classes E and F) are predicted to contribute 40% of hours per year on average, and produce a low degree of atmospheric mixing which results in the poor dispersion of odour.

Table 2-4 is shown for analysis purposes only, as required under the Methods. All winds occurring and all Stability Classes shown have been used in the dispersion modelling undertaken.

Table 2-4: Atmospheric Stability Classes in the Meteorological Data

STABILITY CLASS	A	B	C	D	E	F
% HOURS IN YEAR (2006)	2	15	14	30	13	27

2.4.1.3 WIND SPEED VS STABILITY CLASS

Figure 2-3 is a graph showing the frequency distribution of wind speed as a function of stability class. The most significant trend is that Stability Classes E and F occur more frequently in low wind speed conditions i.e. 0.5 m/s to 3 m/s. Odour events become more likely in these conditions. For example, Stability Class F (very stable) occurs 8% of the modelled hours in winds of 2.5 m/s to 3 m/s but then drops off dramatically with the increase in wind speed.

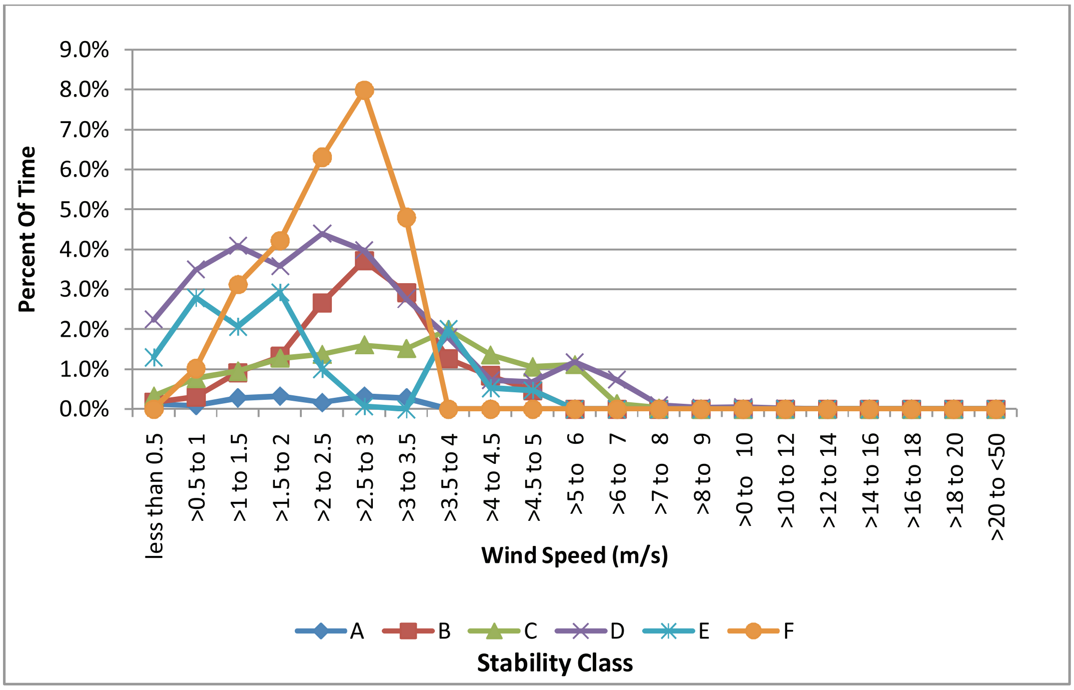


Figure 2-3: Frequency Distribution of Wind Speed and Stability Class

2.4.1.4 WIND DIRECTION VS STABILITY CLASS

Figure 2-4 is a graph displaying the frequency distribution of wind direction as a function of stability class. In plotting the average hourly wind direction (direction from which the wind is blowing) as a function of stability class for the TAPM-generated meteorological data, it can be seen that very stable conditions (Stability Class F) are most prevalent when the wind is blowing from a south easterly direction (approx. 16%). This can be seen in the wind rose in Figure 2-1, with low wind speeds largely originating from the south east. The significance of this south-easterly prevailing wind direction and stable atmospheric conditions is that these conditions would be conducive to odour impacts being experienced in planned residential areas to the north west of the proposed WRP site, as shown in Figure 2-9.

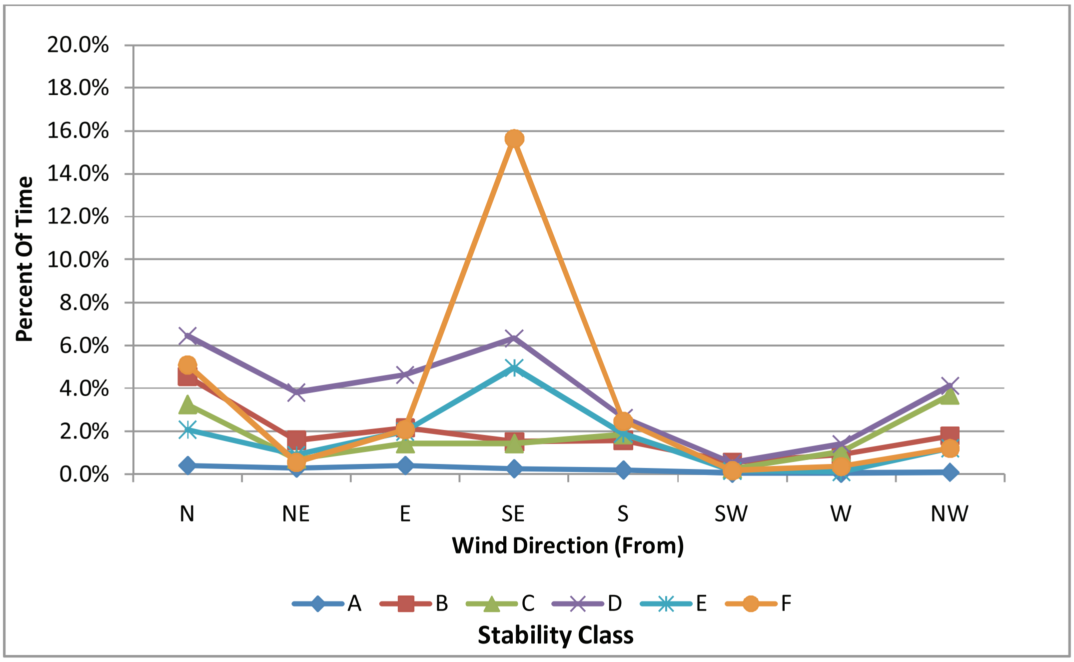


Figure 2-4: Frequency Distribution of Wind Direction and Stability Class

2.4.1.5 AMBIENT TEMPERATURE AND MIXING HEIGHT

Figure 2-5 is a graph showing ambient temperatures in the meteorological data file. It shows that there are no major outliers in the dataset, with an expected seasonal difference in temperature. In the Summer months, the maximum ambient air temperature is 34°C. The minimum ambient temperature for the year is -3°C.

Figure 2-6 shows hourly mixing height values in the meteorological data set. The mixing height is the height to which air near the ground surface is well mixed due to turbulence caused by the interaction between the surface and the atmosphere. The maximum mixing height is 3181 m and the minimum height is 23 m. The mixing height is a function of wind speed and also temperature. During daytime in the warmer months, the combination of warmer conditions and daytime winds promotes the mixing height, while at night, particularly in the cooler months, the mixing height decreases.

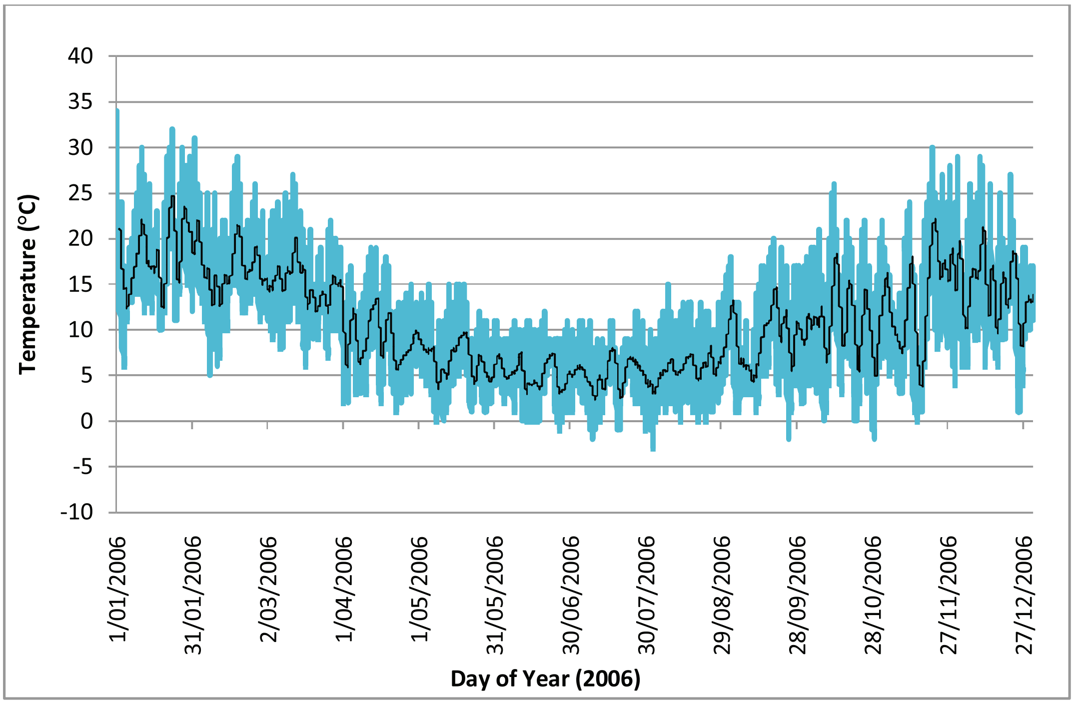


Figure 2-5: Graph of Ambient Temperature in the Meteorological Data

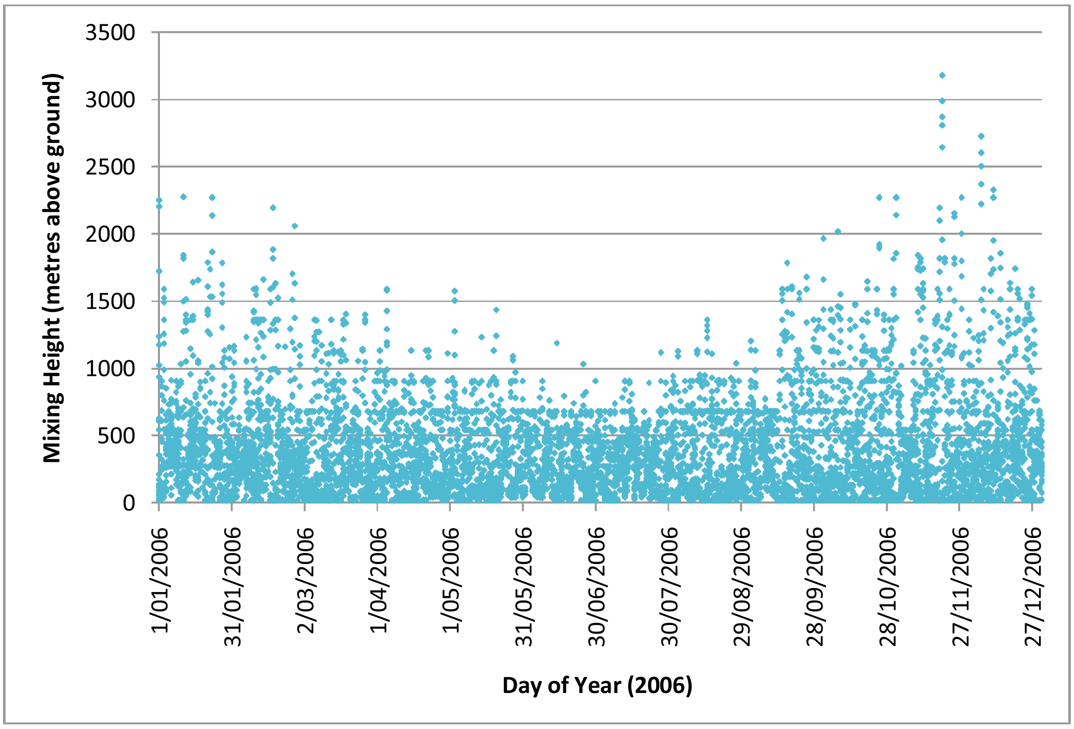


Figure 2-6: Graph of Mixing Height in the Meteorological Data

2.4.2 TERRAIN DATA

A terrain data file has been used in modelling the odour impact of the Stage 1 and Stage 2 development of the Googong WRP. The gridded x (east-west), y (north-south) and z (elevation) data is a representation 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). It should be noted, however, that since wind speed and direction remain constant over the full length of the plume in AUSPLUME, the AUSPLUME model can only partially simulate terrain effects.

When run in 3 dimensional mode, CALPUFF is a suitable model for simulating complex terrain. Terrain adjustments in the CALMET model include vertical velocity (kinematic effects of terrain), Froude number (air flow up and over or around an elevated land surface depending on atmospheric stability and kinetic energy), and slope flow (for example down slope drainage of dense air at night).

The Egan Half Height Approach has been selected as the method of adjustment used in CALPUFF to account for terrain effects. The adjustment method specifies changes in the height of the plume centreline above the local terrain in proportion to the changes in the elevation of the underlying terrain. These changes are a function of the atmospheric stability and allow a closer approach of the odour plume to the terrain surface under stable conditions.

Figure 2-7 shows a true representation of the local terrain at and surrounding the proposed Googong WRP, and assists in visualising the elevation data used in the modelling. As can be seen, the area surrounding the WRP is generally flat. In order to emphasise certain features shown in Figure 2-7, an exaggerated representation of the land surface is provided in Figure 2-8. The terrain profile has been exaggerated vertically by applying a vertical scale 2 times greater than the horizontal scale. As shown, the WRP is situated on a gently sloping plane, on the western side of a ridgeline. Areas of elevated land exist primarily in the west of the modelling domain (shaded in blue). There is a valley (shaded in yellow) to the east of the site.

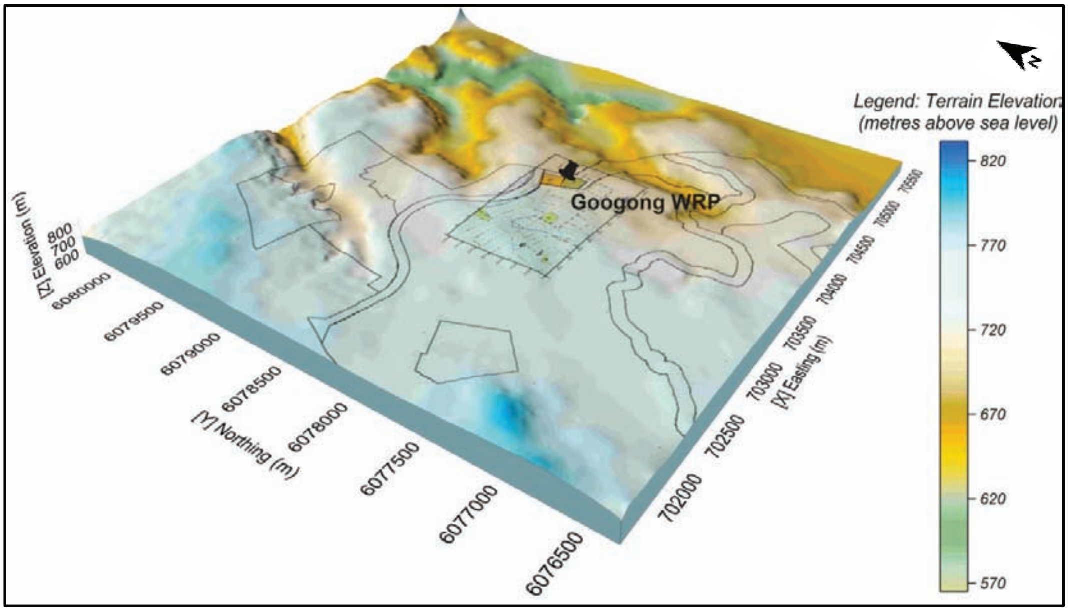


Figure 2-7: True Representation of the Local Terrain at Googong WRP

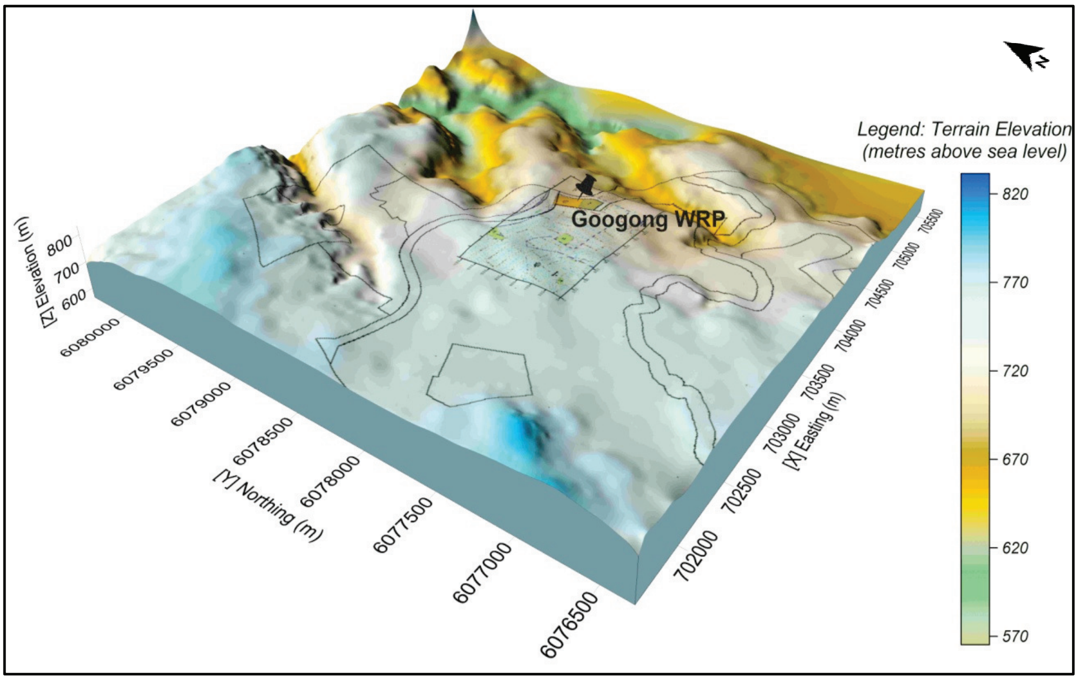


Figure 2-8: Exaggerated Representation of the Local Terrain at Googong WRP (vertical scale 2 times greater than horizontal scale)

2.4.3 SENSITIVE RECEPTORS

A sensitive receptor is defined in The Methods as '*a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area'.*

The Methods require that the odour impact assessment consider the location of existing as well as known or likely future sensitive receptors which may be affected by emissions from the Googong WRP. The location of the nearest sensitive receptor is of most importance when determining the odour impact of the plant and assessing compliance with the DECCW odour impact criteria.

There are a range of possible land uses that could be applied to the areas surrounding the WRP. Although the land uses close to the WRP are yet to be finalised, one possible land use is to have urban areas close to the WRP, such as shown in Figure 2-9. Such an arrangement would be "worst case" for odour impact assessment, as it would require the most stringent odour impact criteria to be complied with. This report therefore considers compliance with the "worst case" conditions, with the outcomes informing the decision making process to set land use surrounding the WRP. By selecting the "worst case" scenario and selecting odour emission controls to meet this "worst case", the full range of land use options surrounding the WRP can be considered.

Figure 2-9 also incorporates the wind rose which summarises the wind patterns in the area containing the WRP (discussed in Section 2.4.1.1 and shown in Figure 2-1).

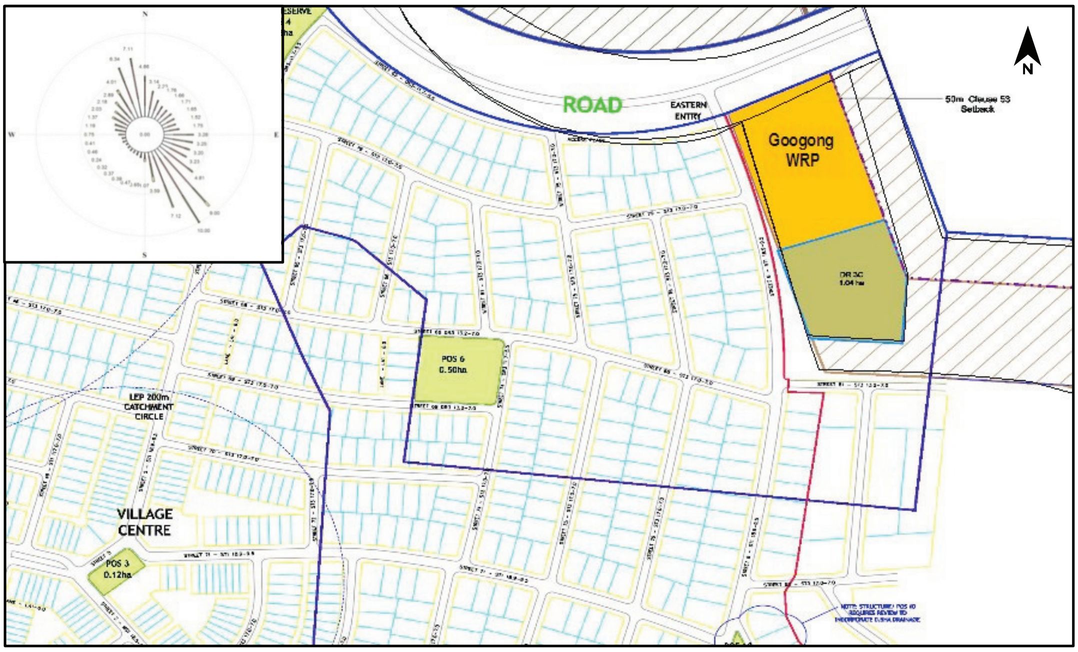


Figure 2-9: Detailed View of Neighbourhood 1A Sensitive Receptors – "Worst Case" Assessment Scenario

3. SEWAGE PUMPING STATION ODOUR MODELLING

The odour impacts of the two sewage pumping stations (SPS1 and SPS2) proposed for the Stage 1 development were modelled, as listed in Table 3-1. Due to the proximity of these pumping stations to planned residential areas and the uncertainty in the flow rates and quality of sewage, both the pumping stations were modelled as being fitted with passive activated carbon odour control units being fitted to the pump station vents. The odour control units were sized on the peak flow for Stage 2 of 19.3 L/s. The activated carbon units were modelled as area sources (to better reflect the low exhaust velocities of the units) and the appropriate peak to mean ratio was applied as described in Section 2.2.

The locations of the pump stations have been shown previously in Figure 1-1 and Figure 1-2.

Table 3-1: Model Parameters for the Sewage Pumping Station Odour Models

SOURCE NAME	LOCATION[1] AND DESCRIPTION OF SURROUNDING TERRAIN	SOURCE TYPE	AIR FLOW (m^3/s)	ODOUR CONC[2] (ou)	UNADJUSTED SOER[3] (ou.m/s)
SPS1	Neighbourhood 1A Flat plane	1 m x 1 m area source	0.02	500	11.8
SPS2	Neighbourhood 1B Side of valley	1 m x 1 m area source	0.02	500	11.8

Note 1: Indicative locations for draft planning stage.
Note 2: CONC: concentration
Note 3: SOER: Specific Odour Emission Rate

3.1 SPS1 RESULTS

The proposed location of SPS1 is in the north of Neighbourhood 1A, in relatively flat terrain. The exact location of SPS1 has not yet been finalised, however it is likely to be in a location similar to that shown in Figure 1-2. SPS1 was therefore modelled on a flat plane without terrain inputs. Due to the uncertainty of the location of SPS1 and the magnitude of the air flow, the 100th percentile (maximum ground level concentration) model predictions have been reported.

Figure 3-1 shows a dispersion plot of the 100th percentile (maximum ground level) odour concentrations for SPS1 with activated carbon odour control. As can be seen, the predicted maximum odour impact of SPS1 does not exceed the 2 ou concentration specified in the DECCW Methods, and hence demonstrates compliance. The odour impact of SPS1 is predicted to be approximately 0.9 ou at a distance of less than 50 m from the proposed SPS1 site.

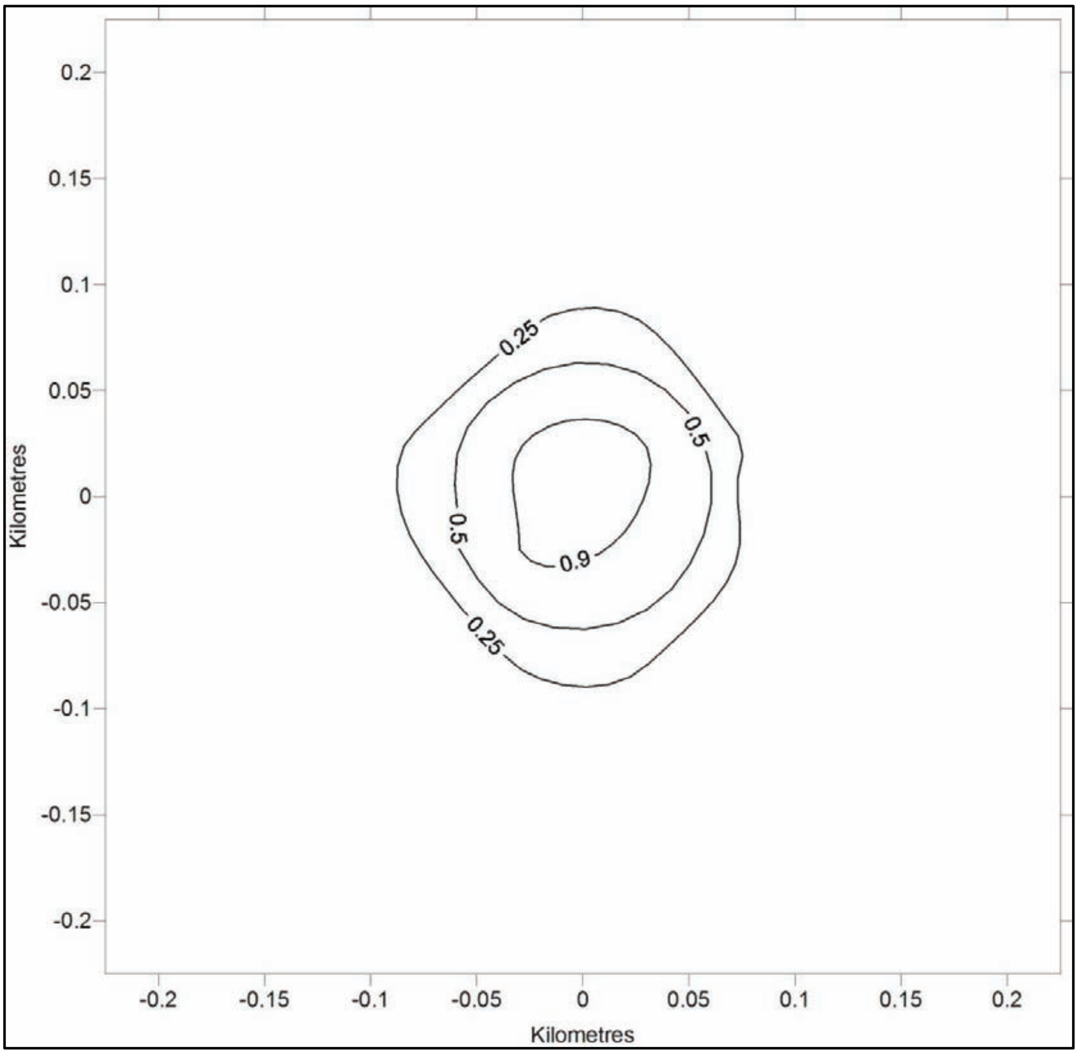


Figure 3-1: SPS1 100th Percentile Plot showing Odour Concentration (in Odour Units)

3.2 SPS2 RESULTS

The proposed location of SPS2 is in the far south-west of Neighbourhood 1B, on the edge of a valley. The exact location of SPS2 has not yet been finalised, but due to the possible impact of the local terrain, SPS2 was modelled at the location shown in Figure 1-2, with terrain inputs included in the modelling. Due to the uncertainty of the location of SPS2 and the magnitude of the air flow, the 100th percentile (maximum ground level concentration) model predictions have been reported.

Figure 3-2 shows a dispersion plot of the 100th percentile (maximum ground level) odour concentrations for SPS2 with activated carbon odour control. As can be seen, the predicted maximum odour impact of SPS2 does not exceed the 2 ou concentration specified in the DECCW Methods, and hence demonstrates compliance. The odour impact of SPS2 is predicted to be approximately 0.9 ou, at a distance of less than 25 m from the proposed SPS2 site.

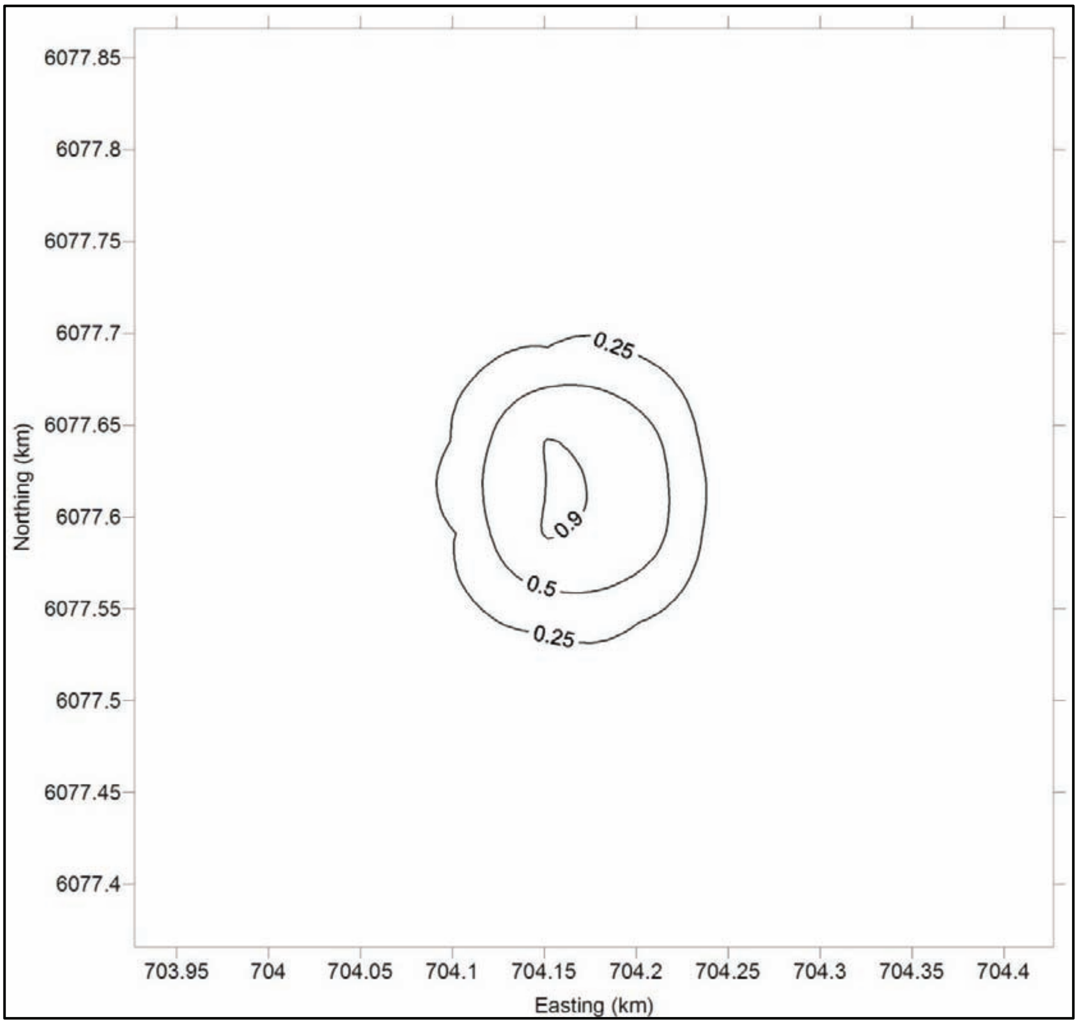


Figure 3-2: SPS2 100th Percentile Plot showing Odour Concentration (in Odour Units)

4. GOOGONG WRP STAGE 1 ODOUR MODELLING

4.1 GOOGONG WRP STAGE 1 BASELINE MODEL

4.1.1 ODOUR EMISSION DATA

Odour emission rates for the Googong WRP Stage 1 Baseline Model (no odour control) were extracted from the MWH Emissions Database and are listed in Table 4-1. The peak odour emission rate (after outliers were removed) was selected for each odour source from a range of olfactometry samples, based upon similar sewage treatment sites and process types. The selected emissions rates for the proposed Googong WRP provide a conservative estimate (being the peak rather than average emission rates) of site conditions and operations expected during Stage 1 and Stage 2 of development.

All odour sources in the Stage 1 Baseline Model (no odour control) have been modelled as area sources. The odour emission rates used in the model have been adjusted by the applicable atmospheric stability class peak to mean ratios (discussed in Section 2.2).

Table 4-1: Odour Sources for the Googong WRP Stage 1 Baseline Model

SOURCE NAME	AREA SOURCES	
	SURFACE AREA (m^2)	UNADJUSTED SOER[1] (ou.m/s)
Inlet Works		
Receiving chamber	4	5.6
Screening 1 (channel, coarse screen, fine screen, screening bins)	7.5	5.6
Vortex and channels	7.9	5.6
Pre-distribution chamber	4	5.6
Bioreactor 1		
Distribution chamber 1	2	5.6
First anoxic zone	45	4
Aerobic zone	82.5	0.7
Deaeration zone	7.5	0.3
Second anoxic zone	15	1.6
Membrane bioreactor	18	0.2
Biosolids Area		
Rotary drum thickener	0.8	0.2
Aerobic digester	49	0.5
Truck outloading (twice a week for 4 hours)	24	1.2

Note 1: SOER: Specific Odour Emission Rate

4.1.2 ASSUMPTIONS

Due to the preliminary level of design of the Googong WRP, a number of assumptions in the modelling process have been made for the Stage 1 Baseline Model (no odour control). These assumptions are:

- The inlet works, aerobic digester and sludge handling process units were modelled as being located on the western side of the treatment plant as a worst case layout (closest to sensitive receptors). The location of these process units was swapped with the location of the administration building, switch room and blower/compressor room shown in Appendix A. The layout used in the modelling is provided in Appendix B.

- Process units assumed to be non-odorous and therefore disregarded in the modelling were the UV modules, chlorination contact tank, foul water tank, and chemical storage facility. The sludge dewatering centrifuge was also assumed to be non-odorous, due to its small size and outer casing adequately containing emissions from the sludge.

- The bioreactor aerobic zone was assumed to have a 20 day sludge age.

- The bioreactor deaeration phase was assumed to contain non-aerated, high mixed liquor sewage

- The biosolids outloading process assumed sludge was outloaded directly from the aerobic digester to the truck, and therefore the emission rate is based on a fresh dewatered biosolids stockpile. The risk of higher odour emissions is likely to increase if the sludge is stored in the truck or a hopper for longer periods (as it is more likely to turn anaerobic), however preliminary designs do not indicate that the biosolids will be stored on site for long periods.

- The outloading of biosolids was modelled using a time-varied emission rate, assuming the activity is carried out twice a week for 4 hours.

4.1.3 STAGE 1 BASELINE MODEL RESULTS

As discussed in Section 2.1, both the 99th and 100th percentile of dispersion modelling predictions have been assessed for the Googong WRP. The predicted ground-level concentrations for the proposed Googong WRP at Stage 1 of development, without odour control, have been assessed using CALPUFF against the 2 ou odour impact assessment criterion, assessed at the sensitive receptor nearest to the boundary of the WRP site.

The 99th percentile predictions would be valid if the data used in the dispersion modelling turns out to be representative of actual conditions on site, and is provided for reference. The 100th percentile predictions are the maximum predicted odour impacts and are reported to comply with the Methods

CIC have advised that land use planning has been undertaken with respect to the 100th percentile predictions.

Figure 4-1 shows the predicted 2 ou 100th percentile (maximum ground-level) and the predicted 2 ou 99th percentile odour concentrations for the Googong WRP Stage 1 Baseline Model (no odour control). As described earlier, 2 ou is the DECCW impact criteria for urban areas.

The 100th percentile contour is shown as the solid red line, and odour concentrations within this contour are predicted to exceed 2 ou for 100 percent of the time. The 99th percentile contour is shown as the dashed red line, and odour concentrations within this contour are predicted to exceed 2 ou for 99 percent of the time.

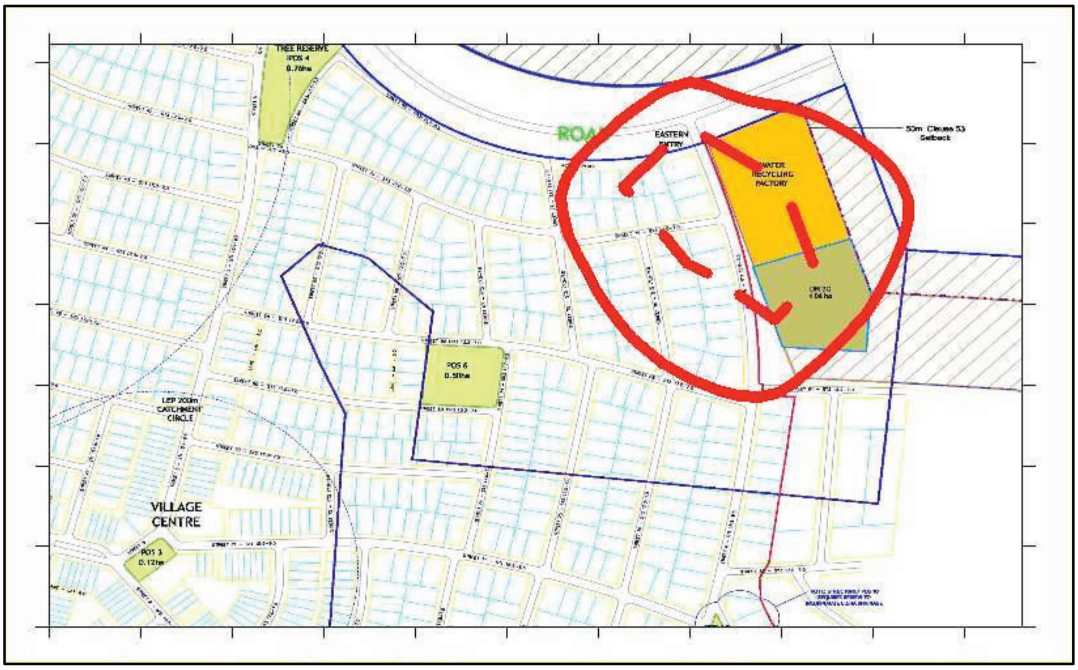


Figure 4-1 Googong WRP Stage 1 Baseline Model Dispersion Plot

Dashed red line = 2 ou 99th percentile odour impact
Solid red line = 2 ou 100th percentile odour impact

4.2 GOOGONG WRP STAGE 1 ODOUR CONTROL MODEL

4.2.1 ODOUR EMISSION DATA

The source dimensions and odour emissions for the Googong WRP Stage 1 Odour Control model are the same as for the Stage 1 Baseline Model (Section 4.1), with the exception of the following process units, which are covered and vented to the new Stage 1 odour control facility:

- Inlet works: receiving chamber; screening 1 (channel, coarse and fine screens, screening bins); vortex grit chamber and channels; pre-distribution chamber
- Bioreactor 1: distribution chamber; first anoxic zone; aerobic zone; deaeration zone; second anoxic zone; membrane bioreactor
- Rotary drum thickener
- Aerobic digester

The only odour source that remains uncovered in the Stage 1 Odour Control Model is the sludge outloading truck. Investigative dispersion modelling showed that the predicted odour impact from an enclosed outloading truck (with odorous air extracted to the odour control facility) would be larger than if the outloading process was not enclosed, therefore the WRP has been modelled with truck loading not enclosed.

Details of the Stage 1 odour control facility used to treat odorous air from the areas listed above are found in Table 4-2.

Table 4-2: Odour Control Facility for the Googong WRP Stage 1 Odour Control Model

SOURCE NAME	ODOUR CONC[1] (ou)	STACK DIAMETER (m)	AIR FLOW (m^3/hr)	STACK HEIGHT (m)	EXIT TEMP[2] (°C)	EXIT VELOCITY (m/s)
Stage 1 odour control facility	500	0.45	9,030	8	25	15.8

Note 1: CONC: concentration
Note 2: TEMP: temperature

The emission rates used in the model have been adjusted by the applicable atmospheric stability class peak to mean ratios (refer Section 2.2). The odour control facility stack was assumed to be a wake-affected point source, and the appropriate peak to mean ratio applied. No specific downwash effects were included in the modelling due to the uncertainty of the site layout. Sensitivity analysis on previous projects has shown that allowing for the Peak to Mean ratios of a wake affected stack in the modelling, without incorporating the actual building dimensions in the modelling, provides similar levels of predicted odour impacts to having the building dimensions incorporated in the modelling. The final WRP design will need to incorporate a building close enough to the stack to ensure building wake effects in order for the selected Peak to Mean ratios to be valid.

4.2.2 ASSUMPTIONS

Due to the preliminary level of design of the Googong WRP, a number of assumptions in the modelling process had to be made for the Stage 1 Odour Control Model. These assumptions were:

- The concept behind the odour control approach was to cover area sources (various tanks and wastewater structures), extract the air from under the covers, send this air to an odour control facility, and discharge the treated air as a point source (stack).The ventilation requirements for the covered areas were defined in terms of air changes per hour under the covers which translates to m^3/s for foul air streams to be treated. Air flows were also sized to ensure that any open inspection covers would not allow the escape of odour. An iterative approach to the modelling was used where gradually increasing numbers of the process units on site were taken to be covered. This was performed in order to define the size of odour control facility in terms of air flow treated required to meet the DECCW odour impact criteria.

- The air flow rate from the bioreactor unit (Bioreactor 1) was set by assuming a 2m x 1m inspection / access hatch is open, requiring 0.5 m/s indraft to keep odours from escaping. Similarly the inlet works air flow rate was set by assuming a 1m x 1m open hatch with 0.5 m/s indraft, and the aerobic digester with a 2m x 1m open hatch with 0.5 m/s indraft.

- All covers on odour sources have assumed 100% capture in the modelling (i.e. no leakage from the covers has been taken into account in predicting the odour impact).

- The Stage 1 odour control facility was modelled with a 500 ou stack discharge concentration. This discharge concentration is equivalent to a biofilter odour control system with an activated carbon polishing stage on the biofilter exhaust before being discharged via a stack.

4.2.3 STAGE 1 ODOUR CONTROL MODEL RESULTS

The predicted ground-level concentrations for the proposed Googong WRP at Stage 1 of development, with odour control measures in place, have been assessed against the 2 ou odour impact assessment criterion.

The modelling predicts that 2 ou at the 99th or 100th percentile would not be reached or exceeded outside of the boundary of the WRP, and therefore compliance with the DECCW odour impact criteria is demonstrated in the Googong WRP Stage 1 Odour Control Model.

5. GOOGONG WRP STAGE 2 ODOUR MODELLING

The initial odour dispersion modelling for the Stage 2 configuration for the Googong WRP was modelled with the assumed Stage 1 odour control measures in place and the additional Stage 2 process units installed without odour control, to determine if the odour control measures for Stage 1 alone were sufficient when Stage 2 was completed.

The modelling of this Stage 2 configuration has not been included in this report, as the predicted odour impact did not comply with DECCW odour impact criteria at the 99th percentile or 100th percentile.

An odour control strategy was modelled for Stage 2 of the WRP development, to demonstrate compliance with the DECCW odour impact criteria. This is described in Section 5.1.

5.1 GOOGONG WRP STAGE 2 ODOUR CONTROL MODEL

5.1.1 ODOUR EMISSION DATA

In establishing the Stage 2 Odour Control Model, the following process units were modelled as being covered and vented to an odour control system with increased airflow to cater for the additional Stage 2 air flows required. The odour emission sources taken to be subject to odour control for Stage 2 were:

- Inlet works: receiving chamber; screening 1 and screening 2 (channel, coarse and fine screens, screening bins); vortex grit chamber and channels; pre-distribution chamber
- Bioreactors 1 - 4: distribution chambers 1 and 2; first anoxic zones; aerobic zones; deaeration zones; second anoxic zones; membrane bioreactors
- Rotary drum thickener
- Aerobic digester

Details of the Stage 2 odour control facility used to treat odorous air from the areas listed above are found in Table 5-1.

Table 5-1: Odour Control Facility for the Googong WRP Stage 2 Odour Control Model

SOURCE NAME	ODOUR CONC[2] (ou)	STACK DIAMETER (m)	AIR FLOW (m^3/hr)	STACK HEIGHT (m)	EXIT TEMP[3] (°C)	EXIT VELOCITY (m/s)
Stage 2 odour control facility [1]	500	0.7	21,630	8	25	15.6

Note 1: Indicates the expanded Stage 1 Odour Control Facility, with additional process units modelled as being covered and a revised air flow drawn from covered areas.
Note 2: CONC: concentration
Note 3: TEMP: temperature

5.1.2 ASSUMPTIONS

Due to the preliminary level of design of the Googong WRP, a number of assumptions in the modelling process had to be made for the Stage 2 Odour Control Model. These assumptions were:

- The air flow rate from the bioreactor units (Bioreactors 1-4) was set by assuming each bioreactor had a 2m x 1m inspection / access hatch open, requiring 0.5 m/s indraft to keep odours from escaping. Similarly for the amplified inlet works, the air flow rate was set by assuming each treatment train (total of 2) had a 1m x 1m open hatch with 0.5 m/s indraft, and the aerobic digester had a 2m x 1m open hatch with 0.5 m/s indraft.

- All covers on odour sources have assumed 100% capture in the modelling (i.e. no leakage from the covers has been taken into account in predicting the odour impact).

- The Stage 2 odour control facility was modelled with a 500 ou stack discharge concentration. This discharge concentration is equivalent to a biofilter odour control system with an activated carbon polishing stage on the biofilter exhaust before being discharged via a stack.

5.1.3 STAGE 2 ODOUR CONTROL MODEL RESULTS

The predicted ground-level concentrations for the proposed Googong WRP at Stage 2 of development, with odour control measures in place, have been assessed against the 2 ou odour impact assessment criterion.

Figure 5-1 shows the predicted 2 ou, 100th percentile (maximum ground-level) odour concentrations for the Googong WRP Stage 2 Odour Control Model. As indicated by the solid red contour line, the predicted 2 ou 100th percentile odour concentration lies outside of the WRP site boundary. This area of exceedance, however, occurs only in a small region across the road from the northern boundary of the plant. Compliance for the Stage 2 Odour Control Model is therefore dependent on the surrounding proposed land use for the Googong Development (see Section 2.4.3). The dispersion modelling predicts that the maximum off-site odour concentration would be 2.2 ou.

Predicted odour impacts at the 2 ou 99th percentile level do not occur outside of the WRP boundary and therefore demonstrates compliance with the DECCW odour impact criteria at the 99th percentile.

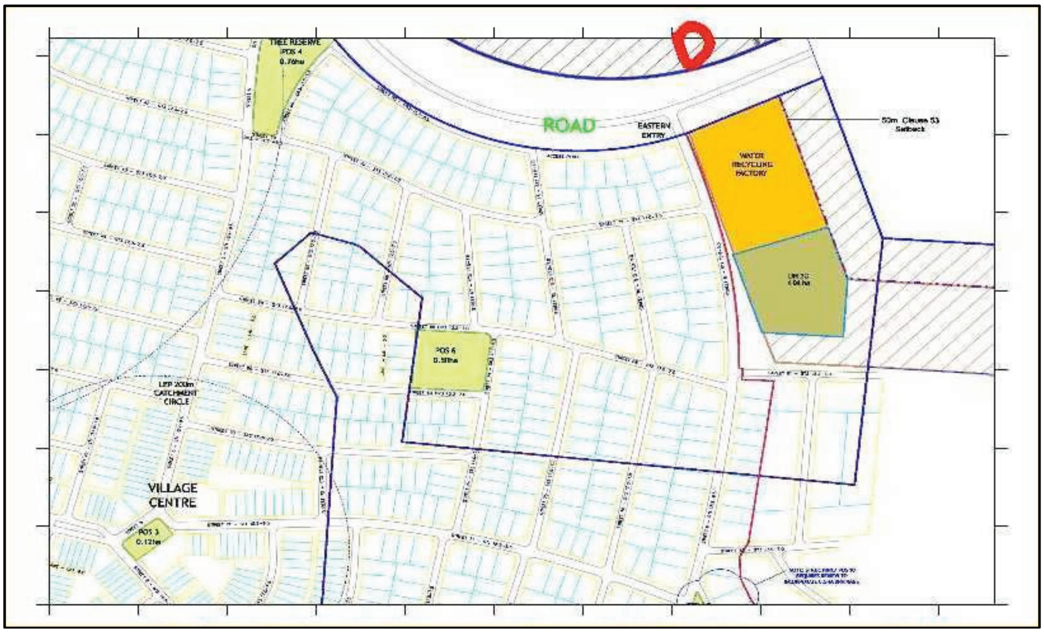


Figure 5-1 Googong WRP Stage 2 Odour Control Dispersion Plot

Solid red line = 2 ou 100th percentile odour impact

6. SUMMARY OF RESULTS

The results of the odour dispersion modelling of the two proposed Stage 1 pumping stations and the proposed Googong WRP for Stages 1 and 2 of development are summarised in Table 6-1.

Table 6-1: Summary of Odour Dispersion Modelling Results

MODELLING SCENARIO	ODOUR CONTROL DESCRIPTION	COMPLIANCE WITH DECCW CRITERION OUTSIDE OF WRP SITE BOUNDARY	
		2 OU, 99th PERCENTILE[1]	2 OU, 100th PERCENTILE
SPS 1 Stage 1 Odour Control	Activated carbon odour control unit installed; no stack required; 500 ou discharge	Yes	Yes
SPS 2 Stage 1 Odour Control	Activated carbon odour control unit installed; no stack required; 500 ou discharge	Yes	Yes
Googong WRP Stage 1 Baseline	N/A (no odour control)	No	No
Googong WRP Stage 1 Odour Control	Inlet works, bioreactor 1, rotary drum thickener, and aerobic digester covered; 8m odour control stack at 500 ou	Yes	Yes
Googong WRP Stage 2 Odour Control	Inlet works, bioreactors 1-4, rotary drum thickener, and aerobic digester covered; 8m odour control stack at 500 ou	Yes	No *(see below for clarification)*

Note 1: odour emission values and meteorological data would need to be confirmed as being site specific before compliance at the 99th percentile could be demonstrated

The dispersion modelling shows that odour control measures would be required for Stage 1 and Stage 2 of development in order for the proposed Googong WRP and the pumping stations to demonstrate compliance with the DECCW odour impact criteria.

The DECCW specifies odour impact criteria based on the population size potentially impacted by dispersed odours. The 2 ou criterion used in the modelling is that which is appropriate for urban residential areas, however the modelling predictions show that the 2 ou criterion is only exceeded outside of the WRP by 0.2 ou at the 100th percentile of predictions for the WRP at Stage 2 (ultimate) development.

For the scenarios evaluated through dispersion modelling, the only scenario that does not comply with the urban odour impact criteria is that for 100th percentile of the Stage 2 development of the WRP. This results in two options being available:

- If the assessment level is to remain at the 100th percentile, land use adjacent to the WRP having a population density less than urban density could be undertaken

- If options for the land adjacent to the WRP are to include urban populations, undertaking site specific data collection for odour emissions and meteorological data and using these data in further dispersion modelling would allow assessment of odour impacts at the 99th percentile. This would allow land use decision making to be made based on the 99th rather than the 100th percentile predictions

These options are discussed in the following sections.

7. RECOMMENDATIONS AND CONSIDERATIONS

Based on the dispersion modelling undertaken for this assessment, the following recommendations are made:

- The dispersion modelling indicates that comprehensive odour control facilities (covering of treatment process units and management of biosolids disposal) will be required in order to meet the DECCW odour impact criteria for urban areas outside of the WRP. The design process to be undertaken to progress the WRP should encompass these odour control measures.

- The odour impact criteria used for the dispersion modelling was that for urban areas. The DECCW criteria is less stringent for areas where non-urban land use occurs. Placing non-urban (lower population density or open space of some form) areas adjacent to the WRP would allow for planned use of the areas surrounding the WRP that would comply with the DECCW odour impact requirements

- The odour impact assessment has been undertaken at the 100th percentile of odour impacts, due to odour emission and meteorological data used in the dispersion modelling being non-site specific. The dispersion modelling shows that the WRP with the odour controls described meets the DECCW criteria at the 99th percentile for both Stages 1 and 2 assuming that the data used is site representative. In order to allow the odour impacts to be assessed at the 99th percentile, site specific data will need to be collected and used in the dispersion modelling. These site specific data could be collected in the following manner:

    - A meteorological station could be established on the proposed WRP site and allowed to collect data for at least 12 months prior to further dispersion modelling being undertaken. Given the timeframes associated with the proposal, approval and development of the New Town site and the WRP in particular, collecting this data should be viable

    - We understand that there will be a staged construction of Neighbourhood 1A, with the WRP and the houses furthest away from the WRP being constructed first. This would provide the opportunity to take odour measurements at the WRP prior to areas closer to the WRP being developed

- The wastewater treatment processes modelled have been taken from preliminary designs. The next phase of process design should look at optimising the designs to minimise the amount of air required to be treated for odour control, as an increase or decrease in air flow can impact on the dispersion modelling predictions.

8. CONCLUSIONS

An odour impact assessment has been undertaken for the two initial wastewater pump stations and the WRP associated with the proposed New Town development at Googong. The odour impact assessment was undertaken using computer based dispersion modelling undertaken in accordance with the NSW DECCW methods to assess compliance with the odour impact criteria set down for urban areas.

The results of the dispersion modelling for the first two proposed pump stations shows that with activated carbon odour control fitted to the pump station vents, the predicted odour impact complies with the DECCW odour impact criteria of 2 ou at the 100th percentile (maximum predicted or “worst case” condition).

Results of the dispersion modelling of the proposed Googong WRP has shown that odour control measures are required for Stage 1 of development in order for the WRP to achieve compliance with the DECCW odour impact criteria of 2 ou at the 100th percentile. For Stage 2 of development, the combined approach of odour control measures at the WRP and appropriate land use planning adjacent to the WRP will result in compliance at the 100th percentile condition, and that odour control measures alone for Stage 2 will allow the predicted odour impact to comply with the 99th percentile assessment condition.

In order for the odour impact assessment to be conducted at the 99th percentile condition, measurement of odour emissions and meteorological conditions at the WRP site would be required. The timeframes for and staging of the development would allow for these data to be collected.

STAGE 1 OF DEVELOPMENT – TWO INITIAL PUMP STATIONS AND STAGE 1 OF THE WRP

Odour control measures as modelled in the Stage 1 Odour Control Model would be required for the Googong WRP Stage 1 development in order for the site to achieve compliance with the DECCW odour impact criteria of 2 ou at the 100th percentile. Specifically, the following Stage 1 process units have been modelled as having odour control applied to them:

- Inlet works: receiving chamber; screening 1 (channel, coarse and fine screens, screening bins); vortex grit chamber and channels; pre-distribution chamber
- Bioreactor 1: distribution chamber 1; first anoxic zone; aerobic zone; deaeration zone; second anoxic zone; membrane bioreactor
- Rotary drum thickener
- Aerobic digester

An odour control facility with the operating parameters shown below would be required to achieve compliance with the DECCW odour impact criteria at the 99th and 100th percentile for Stage 1:

- An airflow of 9,030 m^3/hr
- A stack height of 8 m
- A stack efflux velocity of 15.8 m/s
- A stack odour emission concentration of 500 ou

In addition, the sewage pumping stations proposed for Stage 1, SPS1 and SPS2, would be required to have odour control measures in order to demonstrate compliance with the DECCW odour impact criteria. The odour control measures assumed to be applied to the pump stations are passive activated carbon odour control units, a commonly applied technology for such applications.

STAGE 2 OF DEVELOPMENT – THE WRP CONFIGURED TO ACCOMMODATE ULTIMATE FLOWS

Odour control measures modelled in the Stage 2 Odour Control Model would be required for the Googong WRP Stage 2 development in order for the site to achieve the odour impacts shown in Figure 5-1 (compliance with the DECCW odour impact criterion of 2 ou at the 99th percentile, and 0.2 ou exceedance of the 2 ou criterion at the 100th percentile). Specifically, the following process units have been modelled as having odour control applied to them in the modelling of Stage 2:

- Inlet works: receiving chamber; screening 1 and screening 2 (channel, coarse and fine screens, screening bins); vortex grit chamber and channels; pre-distribution chamber
- Bioreactors 1 - 4: distribution chambers 1 and 2; first anoxic zones; aerobic zones; deaeration zones; second anoxic zones; membrane bioreactors
- Rotary drum thickener
- Aerobic digester

An odour control facility with the operating parameters shown below would be required to achieve the odour impacts shown in Section 5.1.3 for Stage 2:

- An airflow of 21,630 m^3/hr
- A stack height of 8 m
- A stack efflux velocity of 15.6 m/s
- A stack odour emission concentration of 500 ou

The odour impact from the Stage 2 WRP configuration is predicted to exceed the DECCW odour impact criteria for urban areas in a small area outside the boundary of the WRP. The level of exceedance is such that if non-urban land use occurred in this area (such semi-rural development) the DECCW impact criteria for such land use would be complied with at the 100th percentile (maximum) level of predicted impact. Undertaking the odour impact assessment at the current stage of development planning allows the planning process to consider these options.

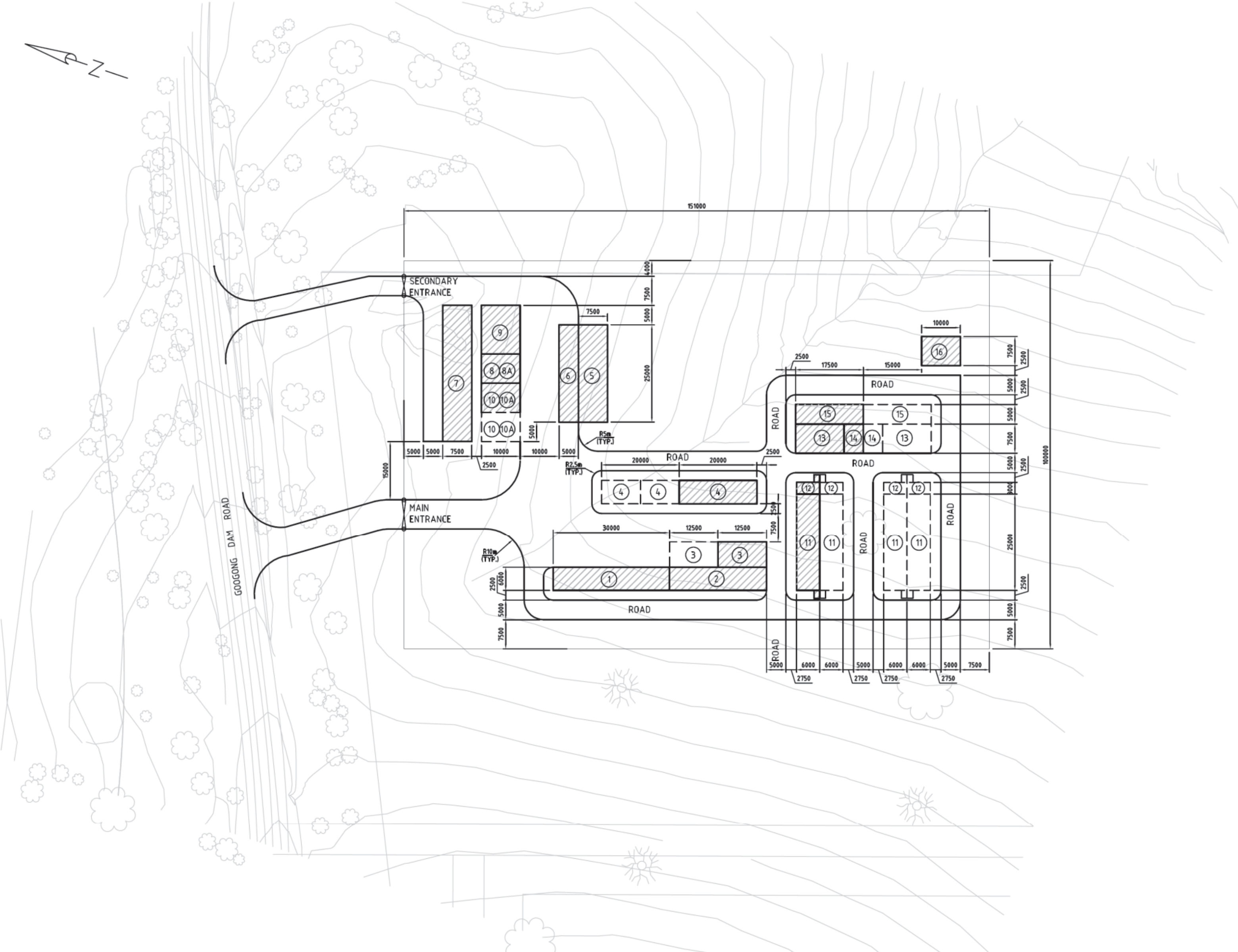
The odour impact assessment has been undertaken at the 100th percentile condition. The DECCW assessment methods allow for the assessment level to be at the 99th percentile where site representative or specific odour emission and meteorological data has been used. Modelling undertaken as part of this assessment shows that the WRP complies with the urban odour impact criteria at the 99th percentile condition if it is assumed that the data used in the modelling is site specific. In order to obtain site specific data, a program of on-site odour and meteorological data gathering is recommended. The dispersion modelling should then be undertaken again to assess compliance at the 99th percentile if the option of urban land use adjacent to the WRP is to be investigated. In the absence of confirmation of compliance at the 99th percentile, it is recommended that planning be undertaken on the basis of compliance with the 100th percentile condition.

9. REFERENCES

1. Protection of the Environment Operations Act 1997 and subsequent amendments, NSW Government
2. ‘Googong Wastewater Study Area’, Document A1154700-G004 Rev E, MWH and CIC December 2008
3. Googong Water Recycling Plant Options Briefing Paper, MWH 2009
4. Approved Methods For The Modelling And Assessment Of Air Pollutants In New South Wales, NSW Department of Environment and Climate Change, August 2005
5. Ausplume Dispersion Model, EPA Victoria, June 2004
6. CalPuff non-steady-state dispersion model, Joseph S. Scire, David G. Strimaitis, Robert J. Yamartino, and Xiaoming Zhang, EARTH TECH, Inc.USA
7. The Air Pollution Model (TAPM), Commonwealth Scientific and Industrial Research Organisation (CSIRO)
8. Victorian Environment Protection Authority's "Plume Calculation Procedure" (EPAV 1985)
9. US ISC3, Bowers et al. (1979)

APPENDIX A

PROPOSED GOOGONG WRP SITE LAYOUT



LEGEND:

1. ADMIN BUILDING/CONTROL ROOM/WORKSHOP/STORAGE.
2. SWITCHROOM
3. BLOWER/COMPRESSOR ROOM
4. ODOUR CONTROL FACILITY
5. CHEMICAL STORAGE
6. CHEMICAL UNLOADING BUND
7. SLUDGE THICKENER/AEROBIC DIGESTER
8. SLUDGE DEWATERING (1st FLOOR)
8A. SLUDGE BINS (GROUND FLOOR)
9. POLY DOSING
10. FINE SCREENING (1st FLOOR)
10A. SCREENINGS BINS (GROUND FLOOR)
11. BIOREACTOR
12. MBR
13. PERMEATE PUMPS/WAS PUMPS/UV
14. BACKWASH WATER TANK
15. CHLORINATION/DECHLORINATION TANK
16. FIRST FLUSH TANK

STAGE 1 WORKS

FUTURE WORKS

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

REVIEW	NAME	SIGNATURE	DATE
DRAWN			
DRAWING CHECK			
DESIGN			
DESIGN CHECK			
PROJ. MANAGER			

REV.	DATE	DESCRIPTION	CHECKED INITIAL	CHECKED DATE	APPROVED INITIAL	APPROVED DATE

CLIENT : Canberra Investment Corporation Limited

PROJECT: GOOGONG CONCEPT TRUNK WATER & RECYCLED WATER SYSTEM

TITLE: SITE LAYOUT PLAN (BARDENPHO – MEMBRANE REACTOR)

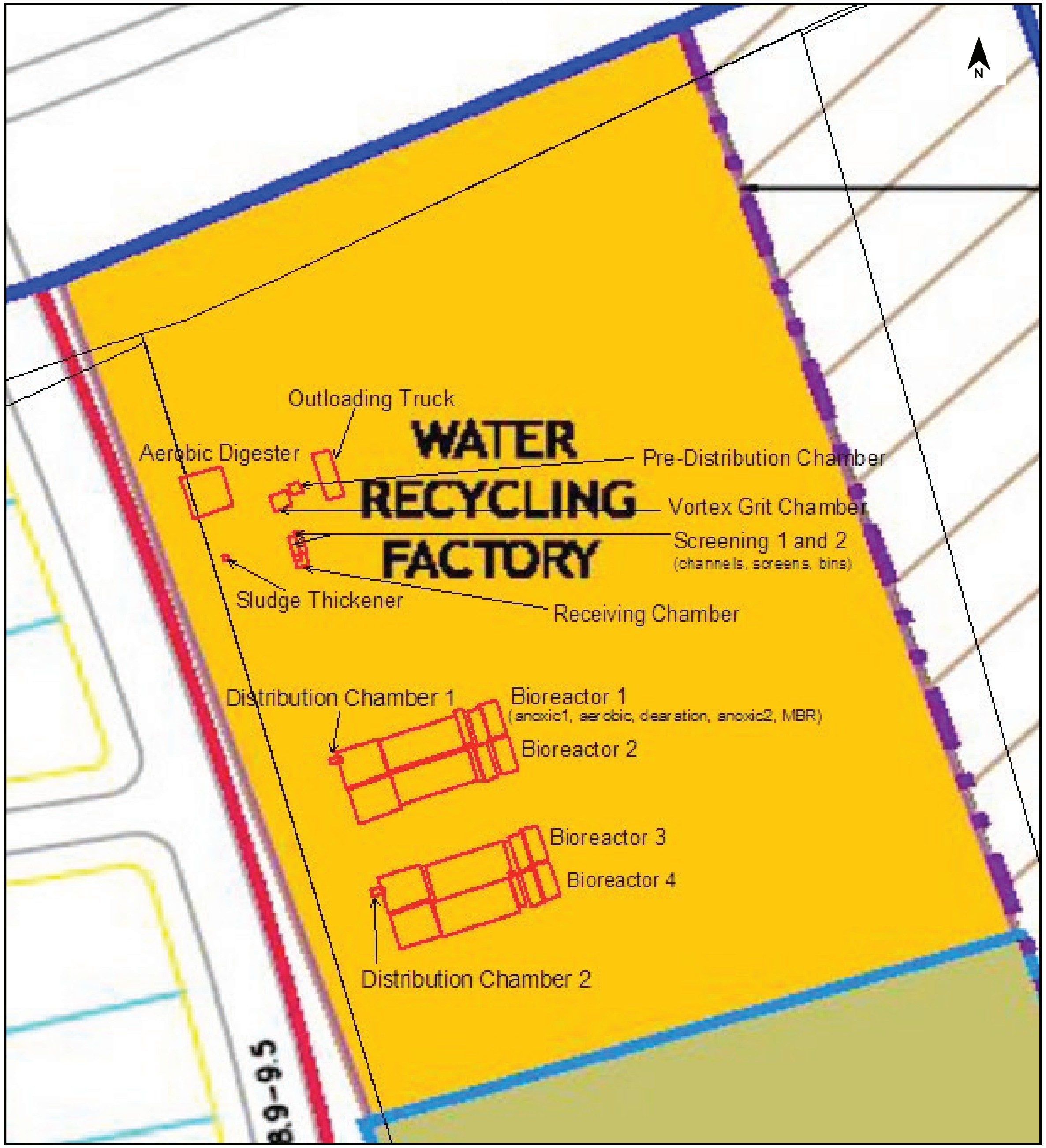
SIZE	SCALE	DRAWING No.	REV.
A1	1:500	MWH-SK-0001	0

P:\Visual\CAD Drawings\Work from other offices\Sydney\A1154700 Googong New Town WTP\MemReactorLayout.dwg, 21/10/2008 8:49:53 AM

APPENDIX B

PROPOSED GOOGONG WRP SITE LAYOUT FOR ODOUR MODELLING

Proposed Googong WRP Site Layout for Odour Dispersion Modelling (shown at Stage 2 of development)

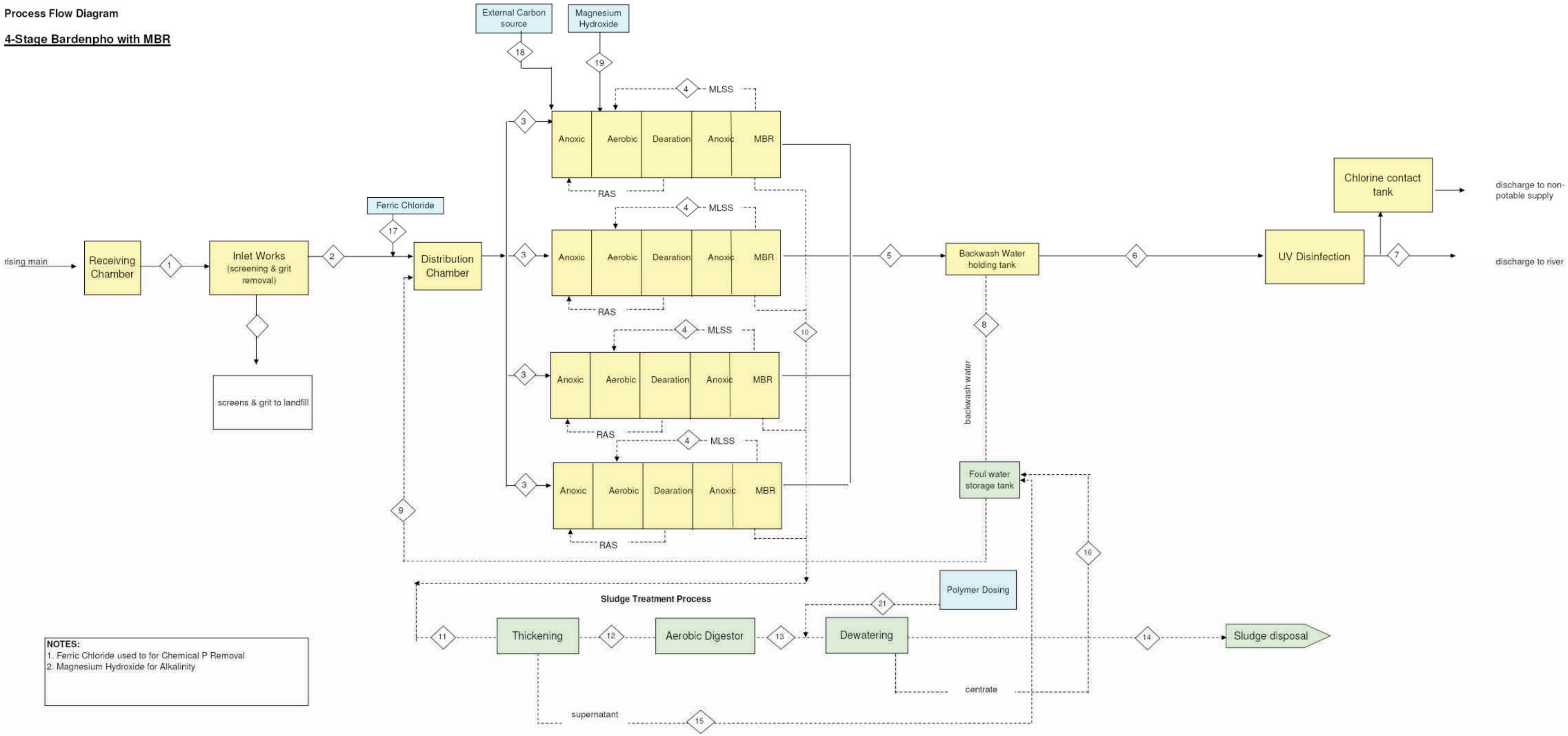


APPENDIX C

PROPOSED GOOGONG WRP PROCESS FLOW DIAGRAM

Process Flow Diagram

4-Stage Bardenpho with MBR



NOTES:
1. Ferric Chloride used to for Chemical P Removal
2. Magnesium Hydroxide for Alkalinity