South West Rocks Waste Water Treatment Plant

KEMPSEY SHIRE COUNCIL

Odour Impact Assessment

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Jacobs SKM
ABN 37 001 024 095
100 Christie Street
PO Box 164
St Leonards NSW
Australia 1590
Tel: +61 2 9928 2100
Fax:+61 2 9928 2500

www.jacobsskm.com

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Contents

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs SKM is to re-assess the size of the odour buffer zone required around the South West Rocks Waste Water Treatment Plant for the existing and proposed future expansion of the facility in accordance with the scope of services set out in the contract between Jacobs SKM and the Client. That scope of services, as described in this report, was developed with the Client.

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1. Introduction

1.1 Background

Kempsey Shire Council (Council) operates the South West Rocks (SWR) Waste Water Treatment Plant (WWTP) at South West Rocks, NSW. Council has previously engaged SKM to complete odour assessments at the SWR WWTP to inform on a suitable environmental buffer zone around the perimeter of the SWR WWTP to adequately manage odour impacts from the facility to acceptable levels. Council has commissioned Jacobs SKM to complete this Odour Impact Assessment to review the effects of proposed future upgrades at the SWR WWTP to ultimate capacity on environmental buffer zone requirements.

The former NSW Department of Planning issued a circular in 1989 that recommended minimum buffer zones of 400 m around WWTPs (DUAP, 1989), but allows for individual increase of the zone sizing based on local conditions. In order to assist local councils to conduct these individual assessments, the Water Directorate developed complementary guidelines to assess the risks associated with permitting developments within the buffer zones (Water Directorate, 2006). Application of the Water Directorate guidelines represents a preliminary assessment, which should be followed up by further investigation if the proposed development is found to be potentially compatible with the requirements of a WWTP buffer zone.

SKM conducted an initial odour modelling assessment in 2005 which found that the buffer zone land was potentially usable (SKM, 2005). This finding was supported by an independent assessment conducted by HLA-Envirosciences (HLA, 2007). Both assessments indicated the need for further work to justify the use of the buffer land for development.

A subsequent odour investigation at the SWR WWTP was completed by SKM in 2008. This assessment considered current existing and proposed odour impacts from the SWR WWTP using measured odour emissions data collected from the plant together with data obtained from Sydney Water Corporation's (SWCs) odour database. The assessment was completed using the AUSPLUME v 6.0 air dispersion model. The assessment estimated that a buffer zone of 150m would be suitable for the current and proposed SWR WWTP at the time (SKM, 2008). This result was consistent with the findings of SKM, 2005 and HLA,2007.

In 2009, an addendum to the 2008 investigation was completed by SKM to assess revised SWR WWTP plant upgrade details, and re-conduct modelling using seasonal worst-case emissions data to predict peak operating period emissions. Modelling during this assessment conferred with the results from the 2008 review that a buffer zone of 150m from the boundary of the SWR WWTP was adequate to manage odour impacts from the facility to acceptable levels (SKM, 2009).

As noted above, Council has commissioned Jacobs SKM to conduct this assessment to review the size of the environmental buffer zone required around the SWR WWTP for the existing and proposed future expansion of the facility to ultimate capacity. It is noted that since the 2008/9 odour assessment the proposed plat upgrades at the time have been completed. Council now propose further upgrades, so the existing plant scenario considered in this report is the same as the proposed plant scenario in 2008/9 and the future plant scenario is a new scenario that has not been previously assessed whereby additional treatment process units are considered by the odour assessment.

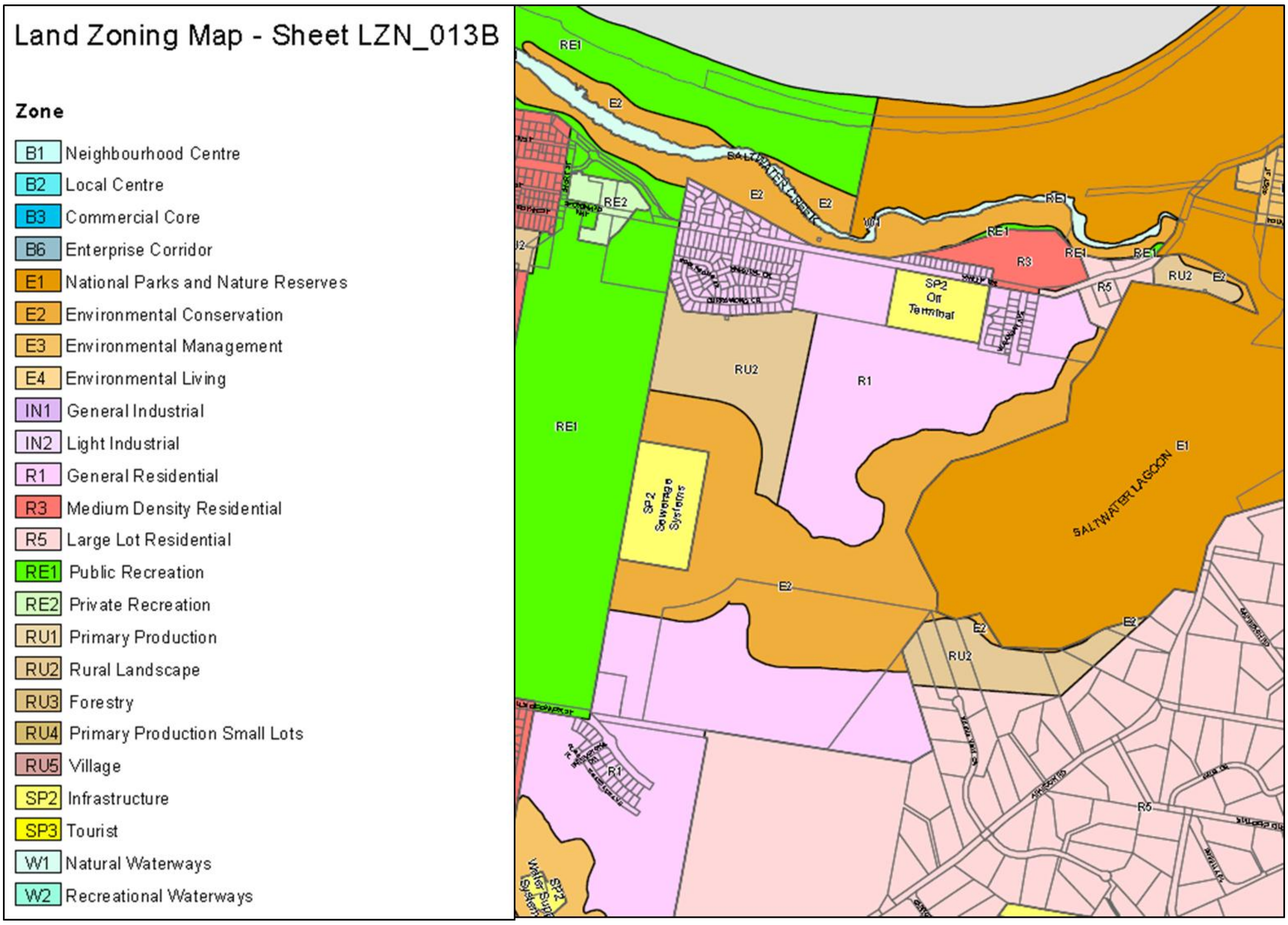
This report also addresses comments made by AECOM, 2009 who reviewed the SKM 2008/09 reports, in a letter to Kempsey Council dated 13 March 2009. The AECOM review concluded *"……….the recommendation of the addendum report, that a buffer zone of 150 m is appropriate to meet the DECC 2 OU criteria, is considered reasonable"*.

The odour assessment contained within this report is based on odour measurements from sources within the existing SWR WWTP (Stephenson May 2008, January 2009) together with data obtained from Sydney Water Corporation's (SWCs) odour database. This was used in dispersion modelling performed using the AUSPLUME v 6.0 model. Modelling was performed in accordance with guidelines developed by the NSW Department of Environment and Climate Change (DECC) (DEC, 2005; 2006).

1.2 SWR WWTP Site Location

The SWR WWTP is located on Belle O'Connor Street in South West Rocks in the Kempsey Local Government Area. The SWR WWTP is surrounded by a 150m environmental conservation area (E2). Beyond the environmental conservation area is rural landscape (RU2) and low density general residential (R1) development to the north, a golf course (public recreation area RE1) to the west, and undeveloped areas zoned for general residential (R1) to the east and south. South West Rocks contains minor areas of commercial and industrial development, national parks and reserves located on relatively flat coastal and riverine plains. The study area is shown below in **Figure 1-1**.

Figure 1-1 Study Area



1.3 Existing and Proposed SWR WWTP Layouts

The SWR WWTP is a secondary wastewater treatment plant consisting of inlet works, three Pasveer Channels that serve as activated sludge reactors, two sludge lagoons and one Sequential Batching Reactor (SBR). The existing nominal capacity of the SWR WWTP is 4000EP.

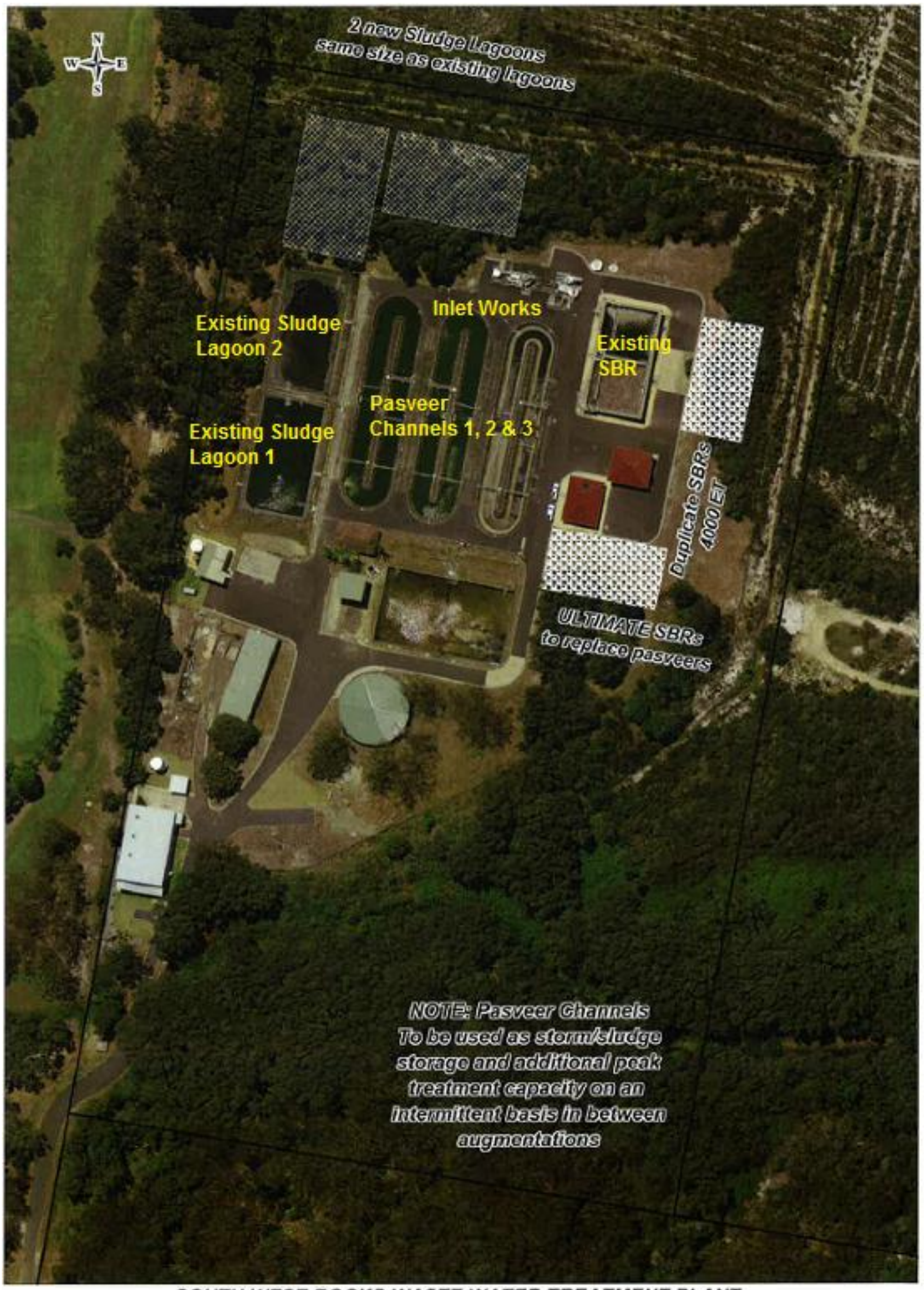
Future upgrades are planned at the SWR WWTP to increase the plant to its ultimate design capacity of 12000EP.The proposed upgrade works involve:

- Installation of two additional SBRs, both identical to the existing SBR;
- Installation of two additional sludge lagoons, identical to the two existing sludge lagoons; and

- Decommissioning of the three existing Pasveer Channels.

The upgrade would allow the plant to be able to accommodate future increases in the local population (the ultimate equivalent population) and the influx of tourists to the area that occurs in the summer months. The existing and proposed layout features of the SWR WWTP are shown below in **Figure 1-2**.

Figure 1-2: SWR WWTP Existing and Proposed Layout Plan



SOUTH WEST ROCKS WASTE WATER TREATMENT PLANT
ULTIMATE CAPACITY CONCEPT LAYOUT PLAN

1.4 Consultation

During the preparation of the initial 2008 detailed assessment, the following organisations were consulted:

- Kempsey Shire Council;
- Macleay Water;
- NSW Planning and Infrastructure (P&I) / NSW Office of Environment and Heritage (OEH); and
- Sydney Water Corporation (SWC) – for access and permission to their odour database.

In preparing this report, Jacobs SKM has consulted with Kempsey Shire Council and has made consideration to the items raised in the peer review report of the 2008 and 2009 SKM Odour Impact Assessment reports (AECOM, 2009).

2. SWR WWTP Buffer Zone Use Planning Guidelines

The Department of Urban Affairs and Planning (now NSW Planning & Infrastructure [P&I]) issued a circular to Councils outlining general policy guidelines for buffer areas surrounding WWTPs (DUAP, 1989). The guidelines state that buffer zones should, ideally, be at least 400 m wide, but that the actual size may vary to suit the local conditions. The widest buffer areas should be established in the direction of the most likely air flows.

A complementary set of guidelines (the Guidelines) were issued to local Councils by the Water Directorate (2006) that provide additional guidance in determining alternate buffer zone sizes based on local conditions. The Guidelines provide a structured approach for assessing and determining appropriate land uses within the 400 m buffer zone based on a risk-assessment methodology.

It is important to note that the Guidelines do not supersede the Government circular, nor do they replace the DECC guidelines relating to odour and air quality management and assessment practices (DEC 2005, 2006). Rather, they provide a methodology for preliminary assessment of land use suitability within WWTP buffer zones. Where buffer zone land is considered to be 'likely' or 'potentially' usable following the application of the methodology outlined in the Guidelines, additional work is required to support any modifications to the buffer zone, such as through odour dispersion modelling.

The Guidelines indicate that off-site impacts of WWTPs can occur in any of the following areas:

- Odour, depending on the offensiveness of the odour, the duration and frequency of exposure, and the tolerance and expectations of the receptor;
- Aerosols, generated from unit processes involving open agitation or aeration of the wastewater;
- Noise and vibration, depending on time of exposure, offensiveness, frequency and level;
- Soil and groundwater contamination by chemicals or raw/partially treated sewage;
- Visual impact, depending on surrounding land uses and perceived beauty of the area; and
- Lighting, which can affect the sleep cycles of people in nearby residential areas.

A preliminary assessment of the SWR WWTP against these Guidelines was completed as part of the 2008 Odour Assessment Report, (SKM, 2008) which concluded that the SWR buffer zone was potentially usable, with additional work required to justify its use. Details of the risk assessment completed are summarised below.

2.1 Risk Analysis

The following assessments have been made:

1) Determination of the Impact Sensitivity Value – The sensitivity of each land use was quantified on a scale of 1 to 5, where 1 represented negligible sensitivity and 5 indicated extreme sensitivity. The Guidelines assign the highest odour sensitivity (4-5) to residential land use. For SWR WWTP, the proposed land use is residential, with a golf course and park land also in the area. A value of 4 was, therefore, assumed for this assessment.
2) Determination of the Impact Potential Value – The likelihood of off-site impacts was quantified on a scale of 1 (lowest impact potential) to 5 (highest impact potential). The Guidelines provide different values for different processes and sizes of WWTP. The Impact Potential for SWR WWTP was determined by averaging the impact potential for the five main WWTP processes [4 for the sludge lagoons and clarifier (biological); 4 for the Pasveer channels (aerobic); and 5 for the inlet works and centrifuge (mechanical)] to provide an Impact Potential of 4.4.
3) Determination of the Overall Mitigation Factor Value – The effectiveness of odour mitigation measures were assigned a mitigation factor between 0 (total elimination of risk) and 1(no reduction in impact). Mitigation

measures include measures such as process design, chemical addition, maintenance and operating procedures, scrubbers and chemical sprays. For the SWR WWTP, SKM allocated the following mitigation factors: 0.5 for the sludge lagoons and Pasveer channels; 0.1 for the clarifier and inlet works; and 0.9 for the mobile belt press. The Guidelines indicate that the overall mitigation factor should be determined by multiplying the different mitigation factors together. For this assessment, however, it was assumed that multiplication of the mitigation factors was only appropriate where the mitigation measures were applied to a single process. As the mitigation measures at the SWR WWTP apply to different processes, the overall mitigation factor was determined by averaging the individual mitigation factors, resulting in a value of 0.42.

4) Determination of the Altered Impact Potential Value - The Altered Impact Potential (1.8) was calculated by multiplying the Impact Potential (4.4) by the Overall Mitigation Factor (0.42).

5) Plotting of results on the Risk Matrix – the Impact Sensitivity (4) and Altered Impact Potential (rounded up) values were then plotted on the Risk Matrix provided by the Guidelines as shown in **Table 2-1**.

Table 2-1 Risk Matrix

		Altered Impact Potential				
		1	**2**	**3**	**4**	**5**
Impact Sensitivity	**1**					
	2					
	3					
	4		**SWR WWTP**			
	5					

400m buffer likely to be useable – further work recommended to justify this

400m buffer potentially usable – additional work required to justify its use

400m buffer unlikely to be usable

3. Summary of Previous Assessments

In the past, a number of studies have investigated odour emissions from the SWR WWTP, including:

- Peter A. Jelliffe, Environmental Engineering and Planning Consultants (Jelliffe): Buffer Zone Assessment South West Rocks STP For the Proposed Subdivision Development South West Rocks (January, 1997);
- Holmes Air Sciences (HAS): Air Quality Assessment – Establishment of a Suitable Buffer Zone for South West Rocks STP (May, 1998);
- Sinclair Knight Merz (SKM): South West Rocks STP – Odour and Noise Assessment (June, 2004);
- Sinclair Knight Merz (SKM): South West Rocks STP – Odour and Noise Assessment (November 2005); and
- HLA-Envirosciences (HLA): Odour and Noise Impact Assessment – South West Rocks Sewage Treatment Plant (May, 2007);
- Sinclair Knight Merz (SKM): South West Rocks STP – Buffer Zone Odour Impact Assessment (June 2008);
- Sinclair Knight Merz (SKM): Addendum – South West Rocks STP Odour Assessment (January 2009);

Two odour assessment surveys have also been completed at SWR WWTP:

- Stephenson Environmental Management Australia (SEMA): Odour Assessment Survey, SKM, South West Rocks, NSW (May 2008);
- Stephenson Environmental Management Australia (SEMA): Odour Assessment Survey, SKM, South West Rocks, NSW (February 2009).

While the above assessment reports also considered noise impacts, only odour is considered in this assessment. Furthermore, the Jelliffe (1997) and Holmes Air Sciences (1998) assessments were based on odour criteria that have since been superseded, and are not discussed further.

Details of the SKM and HLA assessments are summarised in **Table 3-1**.Whereas SKM, 2004; SKM, 2005; and HLA, 2007 used odour emissions derived from existing data from other WWTPs under normal operating conditions, SKM 2008 and SKM 2009 also used measured odour emissions from the SWR WWTP collected by SEMA (May 2008 and February 2009). While SKM 2008 used the measured odour emissions from the May 2008 SEMA survey, SKM 2009 considered the worst-case measured odour emissions from both surveys. All five assessments used 2 OU/m^3 as the criterion for acceptable odour concentration. The maximum size of buffer zone (extent of odour impacts) found to be required under these assessments was 250 m.

Details of the two odour surveys completed by SEMA are discussed below in **Section 4.4.3**.

Table 3-1 Summary of Previous Assessments

Assessment	Meteorology	Existing Sources*	Future Sources	Extent of Odour Impacts
SKM, 2004	Coffs Harbour met station data and TAPM, Jan – Dec 2002	▪ Inlet works ▪ 3 x Pasveer channels ▪ 2 x sludge lagoons ▪ Mobile belt press	▪ Pasveer channel ▪ 2 x sludge lagoons ▪ 2 x clarifiers	250 m
SKM, 2005	TAPM data for July – Sep 2005, nudged with observational data from the on-site weather station	As above	As above	150 m
HLA, 2007	TAPM, Jan – Dec 2006	▪ Inlet works ▪ 3 x Pasveer channels ▪ 2 x sludge lagoons ▪ Mobile belt press	▪ 2 x sequential batch reactors (one anoxic, one aerobic) ▪ 2 x balance ponds	150 m
SKM, 2008	Data from on-site meteorological station collected from July 2005 to June 2006.	As above	▪ Inlet works ▪ 3 x Pasveer channels ▪ 2 x sludge lagoons ▪ Mobile belt press ▪ Sequential batching reactor	150 m
SKM, 2009	Data from on-site meteorological station collected from July 2005 to June 2006.	Not assessed	▪ Inlet works ▪ 3 x Pasveer channels ▪ 2 x sludge lagoons ▪ 2 x Mobile belt press ▪ Sequential batching reactor	150 m
* NB: HLA report modelled only the future scenario; existing sources used in previous studies are provided here for comparative purposes.				

4. Buffer Zone Odour Impact Assessment

4.1 Odour Criteria

The NSW Environment Protection Agency (EPA), formerly the Department of Environment and Climate Change (DECC) regulates air quality in NSW, and has set odour criteria objectives for odour-producing activities such as WWTPs that are intended to minimise the adverse effects of odours on sensitive receptors. Under the Protection of the Environment Operations Act (1997), the South West Rocks WWTP is not permitted to emit any offensive odour beyond the premises (buffer zone) boundary. An offensive odour is defined as one:

that, by reason of its strength, nature, duration, character, or quality, or the time at which it is emitted, or any other circumstances:

(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted.

Odour perception is very subjective and differs between individuals. The DECC assessment criteria were designed to take into account the range of odour sensitivities within a community, and are based on population density as shown in **Table 4-1**.

Table 4-1 Recommended Odour Performance Criteria (complex mixtures of odorous air pollutants)

Size of Affected Community	Odour Performance Criteria # (OU)
Urban (Population ≥ ~ 2000)	2.0
Population ~ 500	3.0
Population ~ 125	4.0
Population ~ 30	5.0
Population ~ 10	6.0
Single Residence (≤ ~2)	7.0

nose-response time average, 99th percentile

The urban odour performance criterion of 2 OU is typically used for odour impact assessments in residential areas, and was adopted for this assessment.

4.2 Existing Air Quality

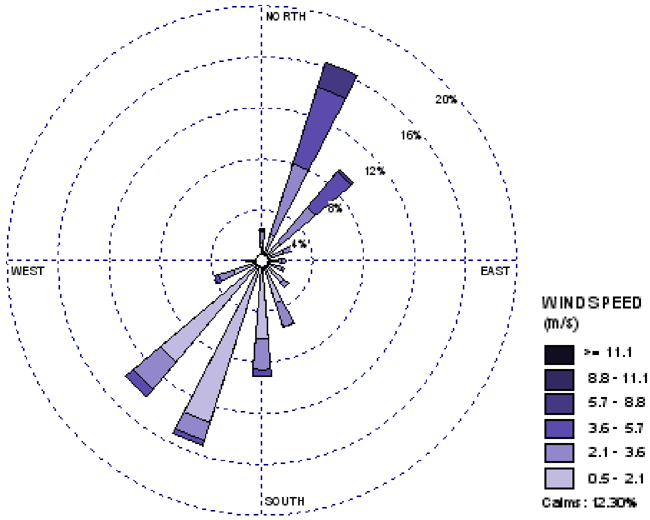
There are few sources of air pollution in the South West Rocks area. There are no major industries in the general vicinity of the site, and the WWTP is the primary potential source of odour in the area.

4.3 Dispersion Meteorology

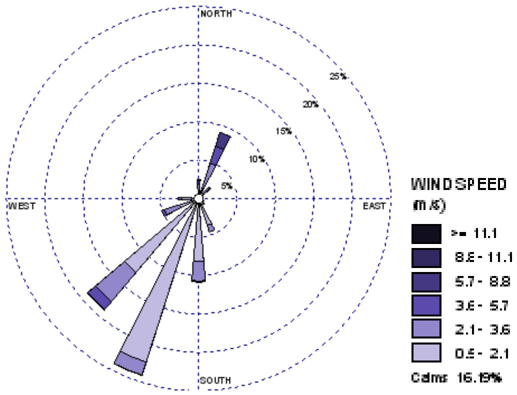
Data collected from the on-site meteorological monitoring station for the 12-month period from July 2005 to June 2006 are summarised in **Figure 4-1**. The monitoring station was installed and operated by Connell Wager in accordance with *AS 2923-1987 Ambient air - Guide for measurement of horizontal wind for air quality applications*.

Winds at the site predominantly blow along the northeast-southeast axis throughout the year, with stronger winds blowing from the northeast. Winds in spring and autumn blow both ways; winds in winter blow predominantly from the southwest, reversing in summer to blow mainly from the northeast. More calm periods occur in winter than the other months. The least number of calm periods were measured in summer, which also had the highest wind speeds.

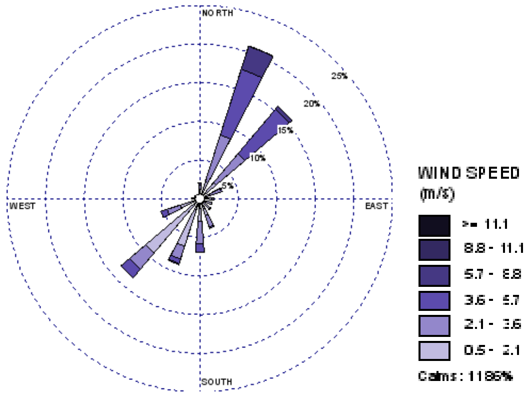
Figure 4-1: Wind Roses: July 2005 – June 2006 (Direction wind blowing from), Source: On-site meteorological station



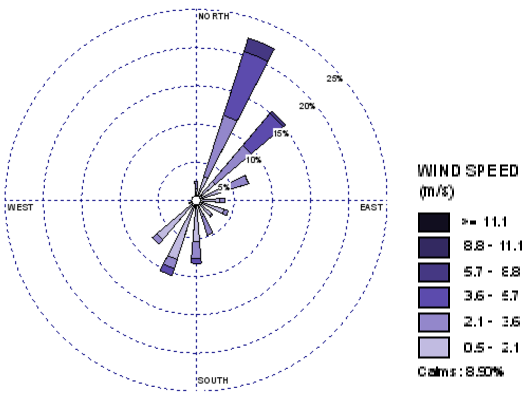
Annual Wind Rose: July 2005 – June 2006



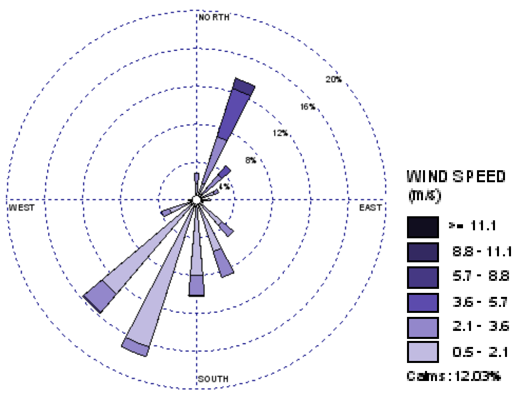
Winter (June – August)



Spring (September – November)



Summer (December – February)



Autumn (March – May)

The nearest automatic weather station (AWS) operated by the Bureau of Meteorology (BoM) is located at Smoky Cape Lighthouse, which is approximately 2.5 km to the east of South West Rocks. Climate averages from this weather station (http://www.bom.gov.au; accessed 29 April 2014) are considered to be indicative of conditions at the SWR WWTP.

Temperature and rainfall data from this weather station are shown in **Figure 4-2** and **Figure 4-3**. Average minimum temperatures range from 19.7°C in summer to 11.2°C in winter, while average maximum temperatures vary from 26.9°C (summer) to 18.7°C (winter). The most rain falls between January and April, with March having the highest average rainfall and number of rain days.

Figure 4-2: Temperature Variation at South West Rocks, 1939 to 2014 (BoM)

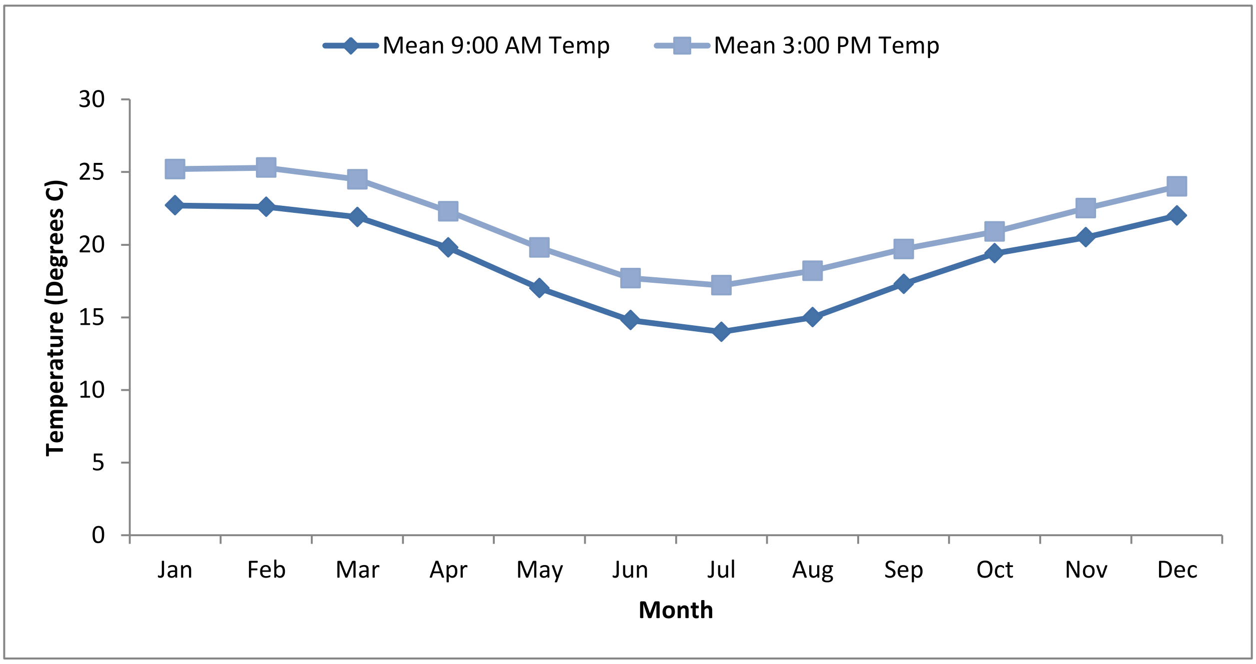


Figure 4-3: Rainfall at South West Rocks, 1939 to 2014 (BoM)

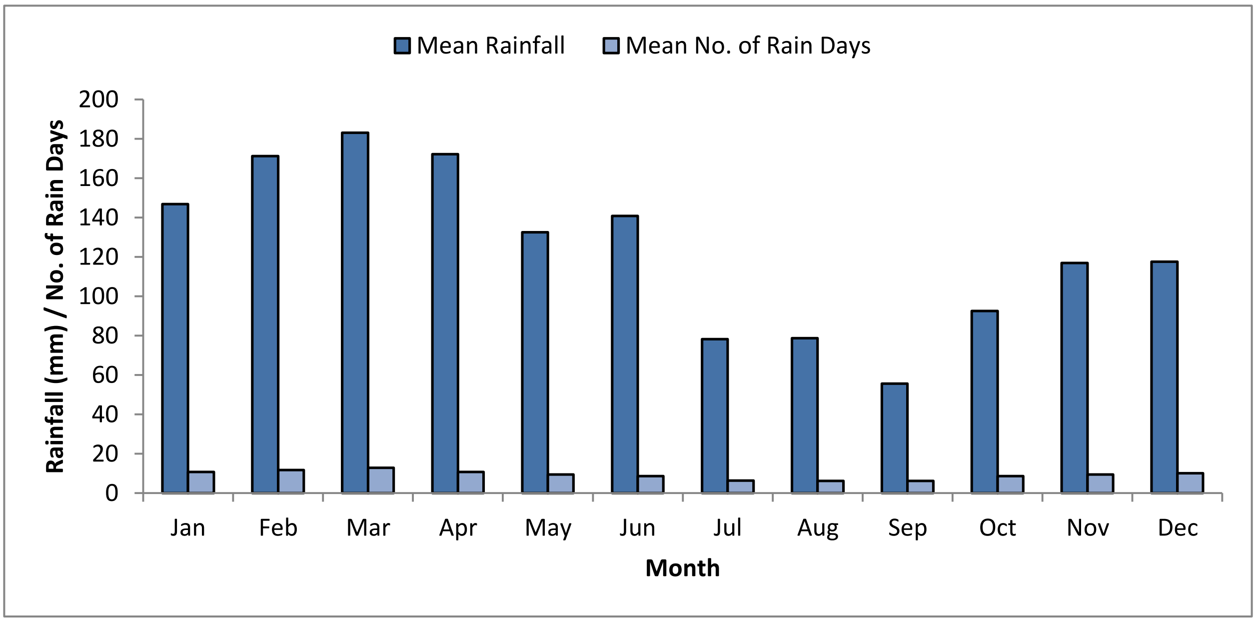
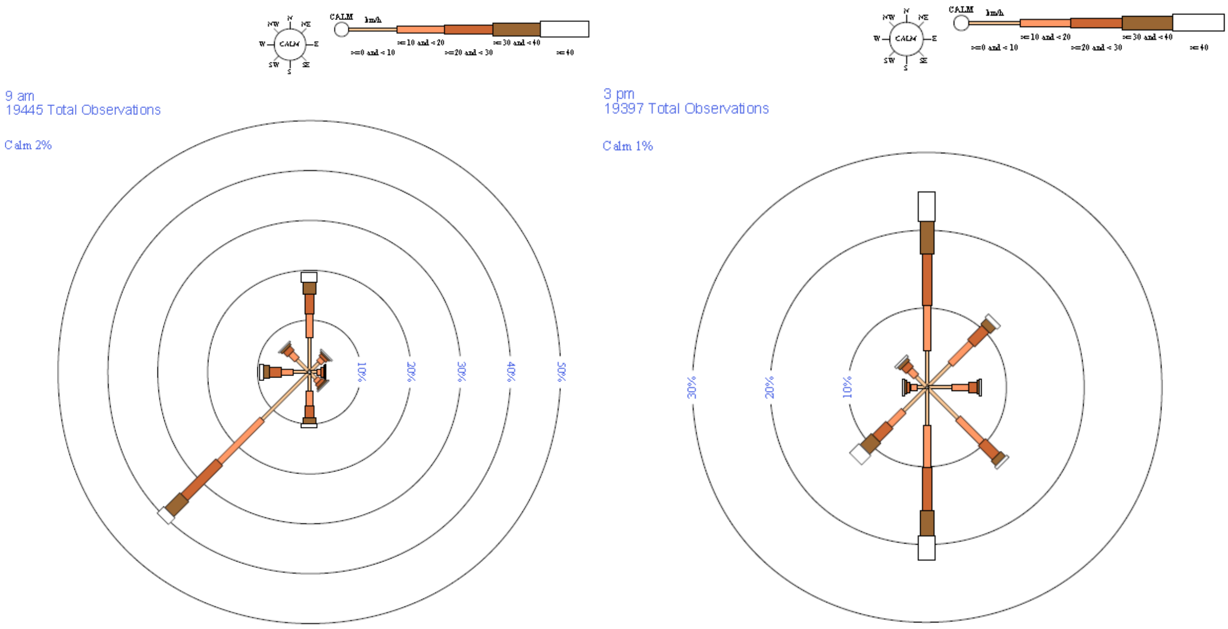


Figure 4-4 below shows 9 am and 3pm annual wind roses from data collected at the Smokey Cape Lighthouse AWS from 1 January 1957 to 30 September 2010.

Figure 4-4: BoM Smokey Cape Lighthouse AWS 9 am and 3 pm Annual Wind Roses (1January 1957 to 30 September 2010)



The annual wind data from the Smoky Cape Lighthouse AWS displays some broadly similar trends to the annual wind data collected on-site at SWR WWTP presented in **Figure 4-1**. Winds predominantly blow from the north, northeast and southwest directions at both locations, at similar wind speeds. Winds appear to blow more from the north than north northeast at Smokey Cape Lighthouse, and winds are also more common from the south. The higher frequency of northerly winds at Smoky Cape compared to South West Rocks where north-east winds are more predominant is expected with the significant terrain of Smoky Cape which would have the effect of steering northerly winds towards the west on the lee side of the cape, resulting in more north-easterly winds at South West Rocks.

In summary the comparison of wind data suggest the on-site meteorological measurements at SWR WWTP provide a representative data set for assessment of odour impacts from the plant.

4.4 Assessment Methodology including Odour Emissions Data

The DECC guidelines (2005, 2006) provide for a range of levels of assessment. The most accurate assessments are performed using site-specific input data, and are referred to as Level 2 assessments when they pertain to air pollutants (DEC, 2005) or Level 3 assessments when referring to odours (DEC, 2006). Site-specific assessments require reporting of the nose response time (1 second) 99th percentile of dispersion model predictions. Model predictions were compared to the DECC criterion for complex odours (2 OU).

4.4.1 Dispersion Model

The AUSPLUME v6.0 model was used to predict odour concentrations within the SWR WWTP buffer zone. AUSPLUME was developed by the Victorian EPA, and is the preferred model for conducting site-specific odour impact assessments in Australia (DEC, 2006).

Inputs required by the AUPLUME model include:

- Emission sources;
- Emission rates;

- Topographical data;
- Locations of sensitive receptors; and
- Meteorological conditions.

4.4.2 Odour Sources

Odour sources investigated in this assessment for the existing SWR WWTP included:

- Inlet works (IW);
- Pasveer channels (PS1, PS2 and PS3);
- Sludge lagoons (SL1 and SL2);
- Centrifuge (CF); and
- Sequential batch reactor (SBR1).

Odour sources investigated for the SWR WWTP proposed future upgrade were the same as the existing arrangement, with the following amendments:

- Removal of Pasveer channels (PS1, PS2 and PS3);
- Addition of two sludge lagoons (SL3 and SL4); and
- Addition of two SBRs (SBR2 and SBR3).

4.4.3 Odour Sampling

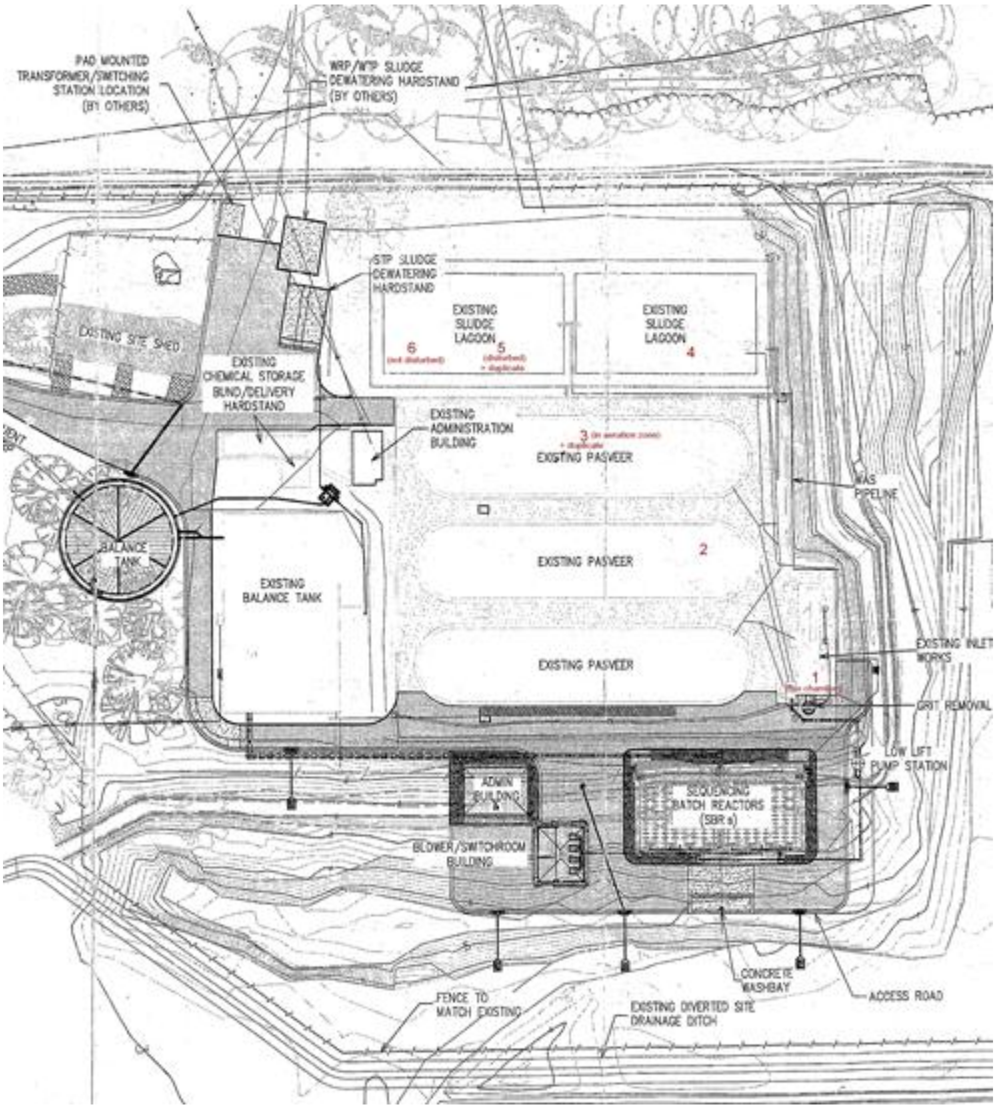
Odour surveys were conducted at SWR WWTP by Stephenson Environmental Management Australia on 22 May 2008 and 5 January 2009. Both rounds of sampling were conducted at the following locations (refer to **Figure 4-5**):

- Inlet works;
- Pasveer channel 2;
- Pasveer channel 3 (in aeration zone, plus a duplicate);
- Sludge lagoon – south (SL1) [one sample taken in undisturbed conditions, and two samples (one duplicate) taken under disturbed conditions]; and
- Sludge lagoon – north (SL2).

The May 2008 round of sampling was conducted to ascertain odour emissions from the locations/features listed above. The subsequent round in January 2009 was undertaken to ascertain odour emission concentrations from the same locations/features above during typical summer holiday season peak loads. The January 2009 sampling was undertaken to ascertain any season trends in odour concentration and/or any increases in odour resulting from peak loads during holiday.

Samples were collected in accordance with AS4323.3 using an equilibrium flux hood, and analysed by Odour Research Laboratories Australia, a NATA-accredited laboratory. Odour reports from both sampling events including sampling methodology, emissions results and quality assurance documentation are provided in **Appendix A**.

Figure 4-5: Stephenson Environmental Management Australia May 2008 and January 2009 Odour Sampling Locations



4.4.4 Sydney Water Corporation Odour Database

The Sydney Water Corporation (SWC) Odour Database contains details of over 1200 odour samples measured at various STPs around NSW, primarily those operated by SWC. A summary of the data relating to processes used at South West Rocks is provided in **Table 4-2**.

- **Table 4-2: Odour Measurement Summary – SWC Odour Database (STPs of all sizes)**

Season	Average Odour Detection Concentrations (OU)									
	Inlet works		Pasveer channel		Reactor*- aerobic		Reactor* - anoxic		Sludge lagoon	
	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.
Summer	16005	12	61	10	278	3	1317	14	909	22
Autumn	8927	14	0	0	582	18	1399	15	2284	16
Winter	2429	4	0	0	605	6	2615	2	519	3
Spring	1250	2	0	0	278	7	2878	12	0	0
Average	10289	32	61	10	497	34	1842	43	1417	41
* Taken to be indicative of SBRs										

Of the processes shown in **Table 4-2**, only the inlet works and sludge lagoons show a clear trend in odour strength with season. The highest odour concentrations for the inlet works were measured in summer, while the highest odour concentrations for the sludge lagoons were measured in autumn. While the number of samples within some of the categories is small, there does not appear to be sufficient evidence within these data to suggest that the worst-case odours for each process will occur in summer, particularly for the sludge lagoons, which are the dominant odour source at the South West Rocks STP.

4.4.5 Modelling Scenarios

Three main scenarios were investigated in this assessment:

- Scenario 1 - Worst-case measured emission levels;
- Scenario 2 - SWC average emission levels; and
- Scenario 3 - SWC worst-case emission levels.

Of the three scenarios, the worst-case measured emission levels and SWC average emission levels were almost identical with the SWC worst-case emission levels significantly higher. Of these scenarios, it is considered reasonable to assume that Scenarios 1 and 2 are representative of the worst-case conditions that are actually likely to occur at the SWR WWTP for normal plant operations. This aside, the third scenario has been included for comparative purposes.

4.4.6 Emission Rate

The odour emission rates for this assessment were derived from the results of the odour sampling and from the SWC odour database. As no samples were taken of the centrifuge, and as the odour database did not contain representative samples of this type of equipment (the measured concentrations of the closest indicative plant were at least 50% lower than the value used in previous assessments), the odour concentration used in previous assessments for this plant [previously considered as a mobile belt press] (SKM, 2004, 2005, 2008 & 2009; HLA, 2007) was again used. The highest seasonal averages for the aerobic and anoxic reactors in the SWC odour database were averaged [i.e. (605 + 2878)/2] and used as the odour concentration of the SBR, as this plant is likely to alternate between aerobic and anoxic conditions. Emissions from the SBR were assumed to be the same for each scenario.

The emissions inventories used in the dispersion modelling are shown in the tables below: **:**

- **Table 4-3** shows data used for the worst-case measured scenarios;
- **Table 4-4** shows the data used for the SWC average case scenarios (existing and proposed plant); and
- **Table 4-5** shows the data used for the SWC worst-case emissions scenarios (existing and proposed plant).

Table 4-3: Scenario 1 Emissions Inventory – Measured Emissions

Odour Source	Odour Concentration (OU)	Sampling speed (m/s)	Source Odour Emission Rate (OU.m^3/m^2.s)	Area (m^2)	Odour Emission Rates* (OU.m^3/m^2.s)	
					Convective Atmosphere (A-D)	Stable Atmosphere (E&F)
IW	941	0.00064	0.605	27	1.51	1.39
PS1>	61	0.00064	0.039	864	0.10	0.09
PS2>	61	0.00064	0.039	864	0.10	0.09
PS3>	61	0.00064	0.039	864	0.10	0.09
SL1	1106	0.00064	0.711	684	1.78	1.64
SL2	1106	0.00064	0.711	684	1.78	1.64
SL3#	1106	0.00064	0.711	684	1.78	1.64
SL4#	1106	0.00064	0.711	684	1.78	1.64
Centrifuge	2000	0.00038	0.760	21	1.90	1.75
SBR1	1244	0.00038	0.473	396	1.18	1.09
SBR2#	1244	0.00038	0.473	396	1.18	1.09
SBR3#	1244	0.00038	0.473	396	1.18	1.09

* Including peak to mean ratios (2.5 for convective conditions and 2.3 for stable conditions)
\# SL3, SL4, SBR2 and SBR3 included in future scenario only.
> PS1, PS2 and PS3 included in existing scenario only.

The odour concentration assigned to each of the three Pasveer channels was the highest value sampled at the SWR WWTP. The highest odour concentrations measured at the SWR WWTP sludge lagoons was used to model all four sludge lagoons.

Table 4-4: Scenario 2 Emissions Inventory –SWC Average Emissions^

Odour Source	Odour Concentration (OU)	Assumed Sampling speed (m/s)	Source Odour Emission Rate ($OU.m^3/m^2.s$)	Area (m^2)	Odour Emission Rates* ($OU.m^3/m^2.s$)	
					Convective Atmosphere (A-D)	Stable Atmosphere (E&F)
IW	10289	0.00038	3.910	27	9.77	8.99
PS1>	61	0.00064	0.039	864	0.10	0.09
PS2>	61	0.00064	0.039	864	0.10	0.09
PS3>	61	0.00064	0.039	864	0.10	0.09
SL1	1417	0.00038	0.538	684	1.35	1.24
SL2	1417	0.00038	0.538	684	1.35	1.24
SL3#	1417	0.00038	0.538	684	1.35	1.24
SL4#	1417	0.00038	0.538	684	1.35	1.24
Centrifuge	2000	0.00038	0.760	21	1.90	1.75
SBR1	1170	0.00038	0.445	396	1.11	1.02
SBR2#	1170	0.00038	0.445	396	1.11	1.02
SBR3#	1170	0.00038	0.445	396	1.11	1.02

^ emissions taken from Sydney Water Corporation Odour Database
* Including peak to mean ratios (2.5 for convective conditions and 2.3 for stable conditions)
\# SL3, SL4, SBR2 and SBR3 included in future scenario only.
> PS1, PS2 and PS3 included in existing scenario only.

The overall average emissions shown in **Table 4-2** were used for in the average emission scenario with the exception of the SBR and the Centrifuge. The highest seasonal average values from **Table 4-2** were used in the worst-case emission scenario, again with the exception of the SBR and Centrifuge.

- **Table 4-5: Scenario 3 Emissions Inventory – SWC Worst-Case Emissions^**

Odour Source	Odour Concentration (OU)	Assumed Sampling speed (m/s)	Source Odour Emission Rate ($OU.m^3/m^2.s$)	Area (m^2)	Odour Emission Rates* ($OU.m^3/m^2.s$)	
					Convective Atmosphere (A-D)	Stable Atmosphere (E&F)
IW	16005	0.00038	6.082	27	15.20	13.99
PS1>	61	0.00064	0.039	864	0.10	0.09
PS2>	61	0.00064	0.039	864	0.10	0.09
PS3>	61	0.00064	0.039	864	0.10	0.09
SL1	2284	0.00038	0.868	684	2.17	2.00
SL2	2284	0.00038	0.868	684	2.17	2.00
SL3#	2284	0.00038	0.868	684	2.17	2.00
SL4#	2284	0.00038	0.868	684	2.17	2.00
Centrifuge	2000	0.00038	0.760	21	1.90	1.75
SBR1	1741	0.00038	0.662	396	1.65	1.52
SBR2#	1741	0.00038	0.662	396	1.65	1.52
SBR3#	1741	0.00038	0.662	396	1.65	1.52

^ emissions taken from Sydney Water Corporation Odour Database
* Including peak to mean ratios (2.5 for convective conditions and 2.3 for stable conditions)
# SL3, SL4, SBR2 and SBR3 included in future scenario only.
> PS1, PS2 and PS3 included in existing scenario only.

The SWR WWTP incorporates biological treatment systems that rely on microbes to break down sewage. Increased influent levels can change sewage properties such as biological oxygen demand (BOD) and levels of potentially odour-producing compounds in a WWTP. Microbial populations, however, should self-regulate according to the available food levels when the WWTP is operated appropriately, leading to relatively stable odour emissions from a facility.

The primary variables affecting odour emissions from a WWTP are the type of microbes used in the system, the quality of the inputs (levels of BOD and nitrogenous and sulphurous compounds), the time difference between sewage generation and treatment, and maintenance procedures. Extended time delays between generation and treatment, and poor maintenance of sludge lagoons can result in the sewage or sludge becoming septic. These variables were assumed to be approximately the same for each phase of the development; as such, emissions from each source were assumed to be the same for the existing and future cases of each scenario investigated. The only difference between the existing and proposed cases within each scenario was, therefore, the addition of the two identical sludge lagoons, two identical SBRs and removal of the three Pasveer channels for the proposed case.

4.4.7 Sensitive Receptors

The term sensitive receptors refers to all nearby receptors that may potentially be affected by odour emissions, both now and in the future. As this assessment was limited to the DUAP 400m recommended buffer zone, which currently contains no sensitive receptors, no specific receptor locations were incorporated into the model. Rather, odour concentrations were predicted at each point in the modelling domain grid.

4.4.8 Meteorological Data

Data for July 2005 – June 2006 were obtained from the on-site meteorological station by Connell Wagner. The data were formatted for use in the AUSPLUME model. Wind roses prepared from the data are presented in **Figure 4-1**; quality assurance checks of the data are provided in **Appendix B**.

4.5 Odour Impact Assessment

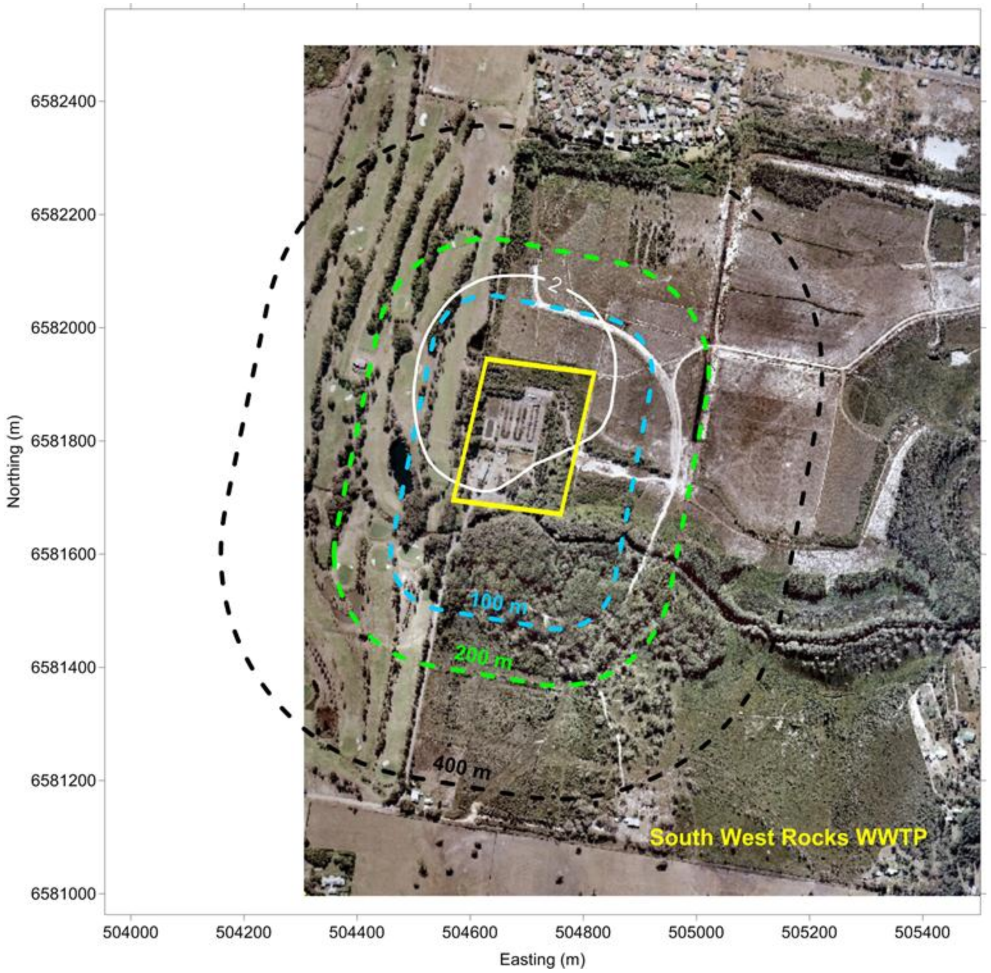
The results of odour modelling are shown in **Figure 4-6** to **Figure 4-8**. In these figures, the black dashed line indicates the DUAP recommended 400 m buffer zone, the blue dashed line is setback 100 m from the SWR WWTP boundary, and the green dashed line is setback 200 m from the boundary. The solid white line shows the 2 OU/m^3 odour criterion level for the 99^{th} percentile odour concentration predictions.

The following points should be noted when reviewing the figures:

- The measured scenario (Scenario 1) uses worst-case data measured on-site for the inlet works, Pasveer channels and sludge lagoons;
- The difference between the existing and proposed (ultimate) cases are addition of the two identical sludge lagoons, two identical SBRs and removal of the three Pasveer channels for the proposed case.
- The average scenario (Scenario 2) considered the plant operating with average odour emissions for the inlet works and sludge lagoons obtained from the Sydney Water Corporation odour database;
- The worst-case scenario used the worst-case seasonal average odour emissions from the odour database for the inlet works and sludge lagoons;
- All scenarios assume the operation of a centrifuge with a worst-case odour concentration of 2000 OU.

Figure 4-6: Scenario 1 Worst-case Measured STP Odours – Existing vs Proposed Plant

Existing



Proposed

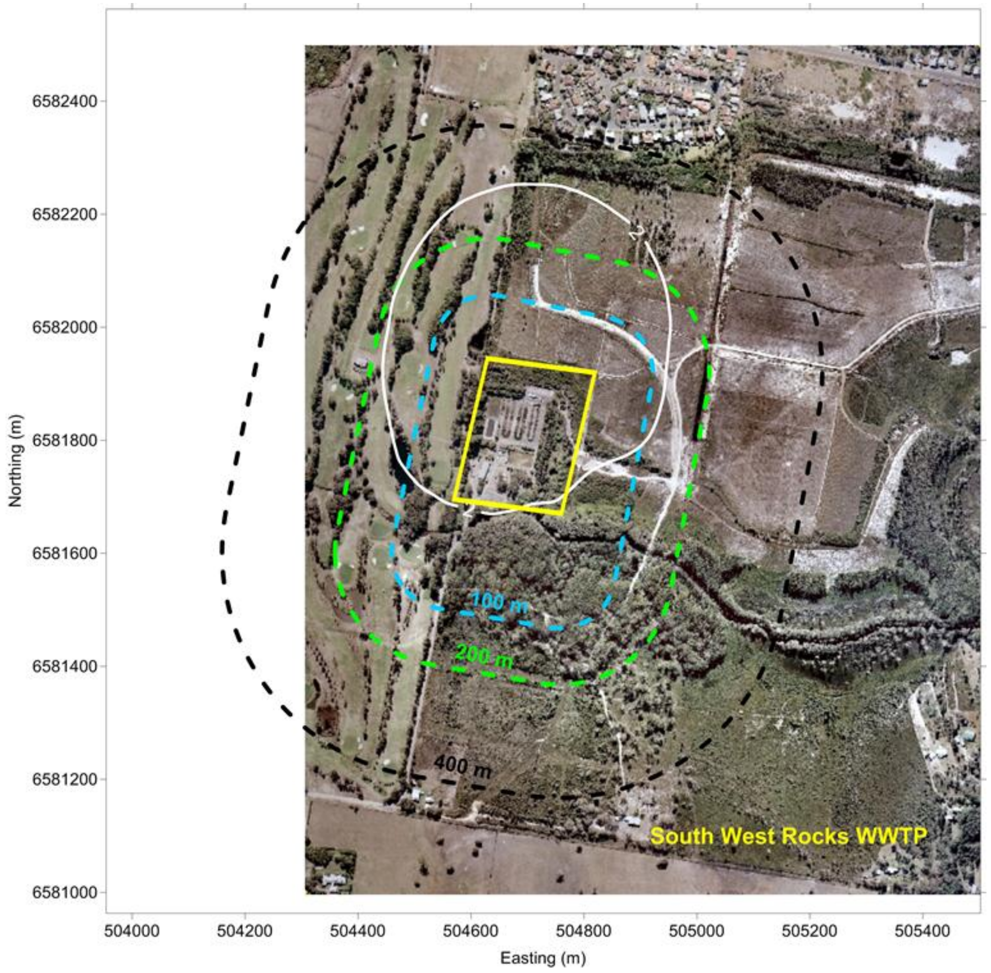
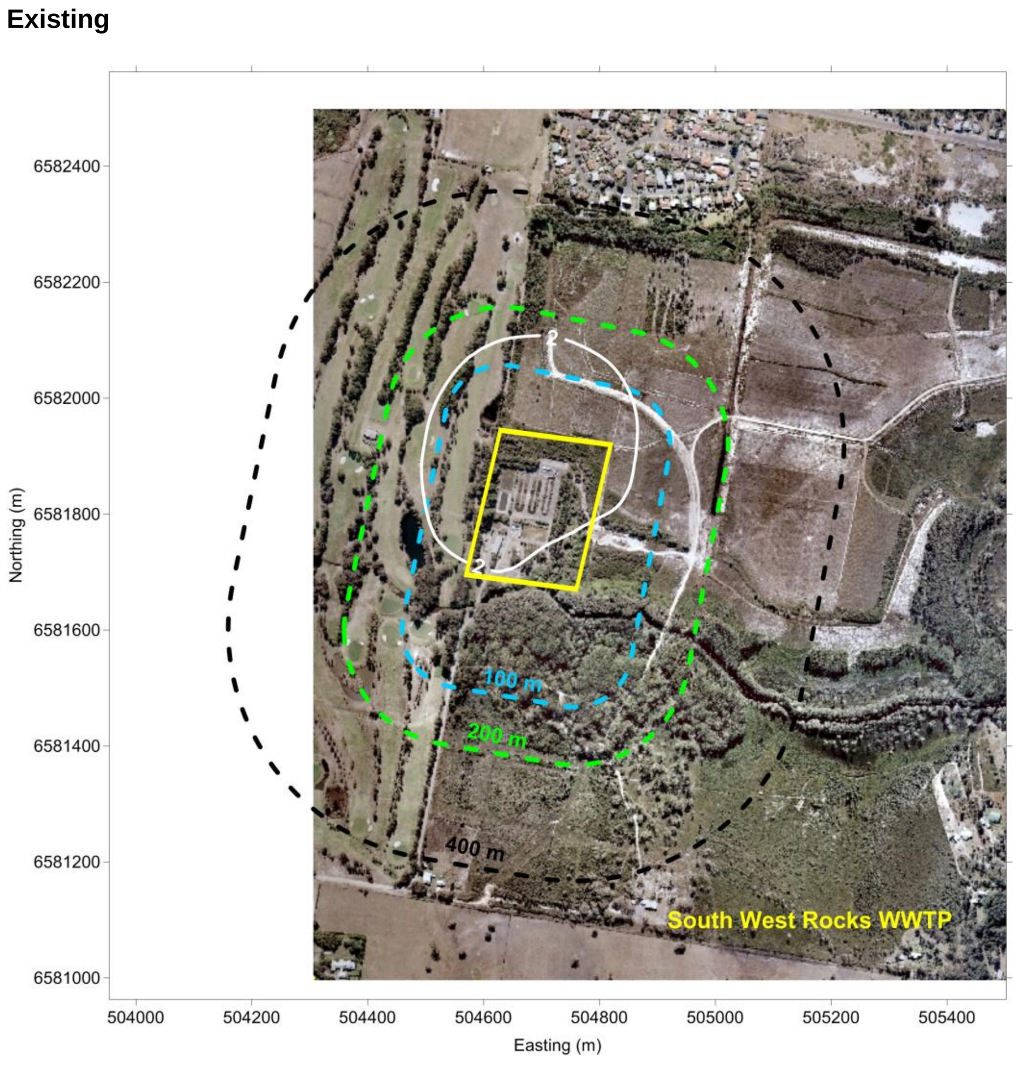


Figure 4-7: Scenario 2 Average STP Odours – Existing vs Proposed Plant



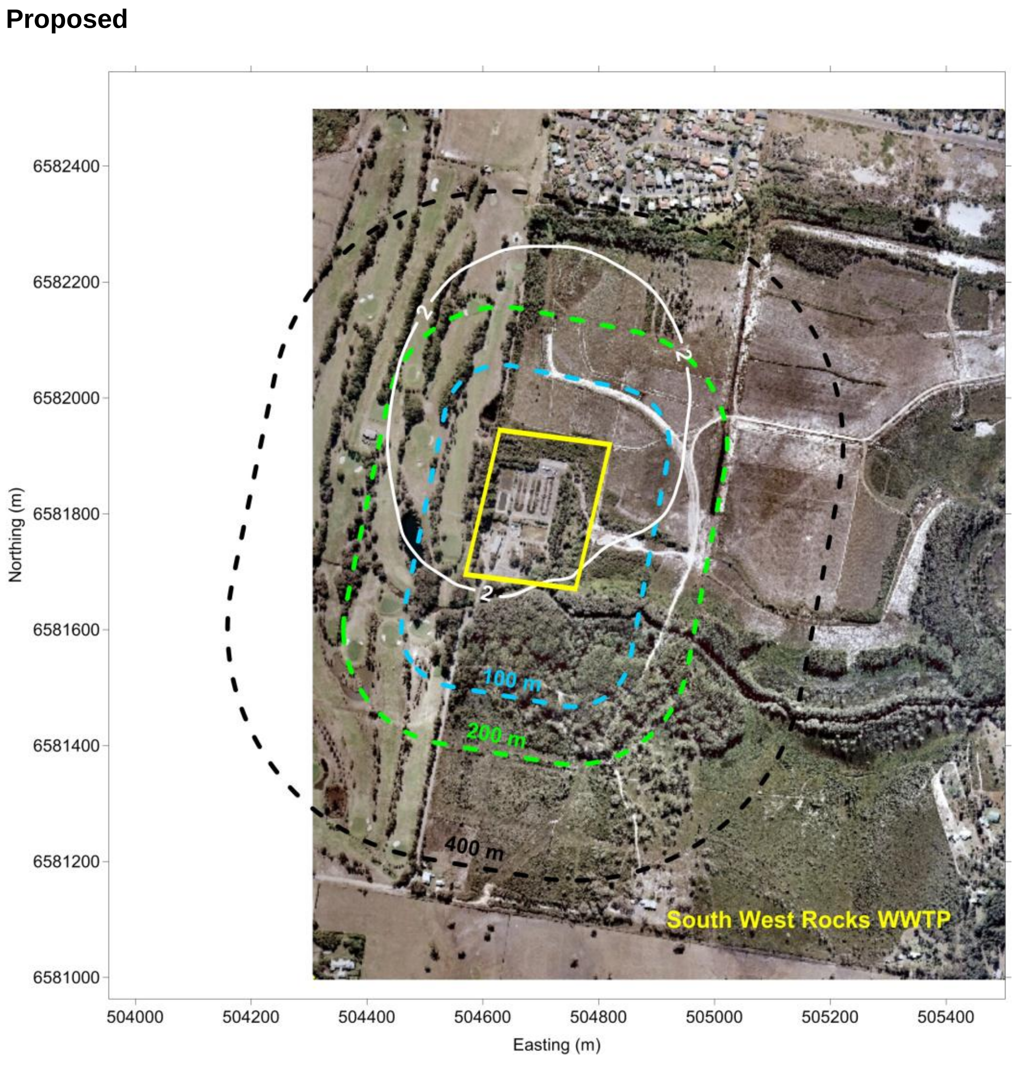


Figure 4-8: Scenario 3 Worst-case STP Odours – Existing vs Proposed Plant

Existing

Proposed

4.6 Discussion of Results

4.6.1 Existing SWR WWTP

As shown in **Figure 4-6** to **Figure 4-8**, odour concentrations from the existing plant are at acceptable levels at approximate distances of 140 m for Scenario 1, 160 m for Scenario 2 and 300 m for Scenario 3 from the facility.

Previous dispersion modelling assessments performed for the SWR WWTP indicated that odour impacts were likely to be limited to within 150 m to 250 m of the facility. The most recent assessments in 2009 present two scenarios as follows:

- 2009 Scenario 1: Measured peak load odour levels, January 2009 to ensure peak load conditions are considered; and
- 2009 Scenario 2: Worst case measured odour levels for each odour source, (May 2008 and Jan 2009 odour sampling)

The 2014 Scenario 1 for the existing plant is similar to the 2009 Scenario 2 and presents similar odour impacts, with a recommended buffer of 160 m compared to 150 m in 2009. The 2014 Scenario 2 which assumes average emissions taken from the SWC odour database apply also suggests a buffer distance of 150 m. Scenario 3 representing emissions equal to worst-case SWC emissions suggests a 300 m buffer is required. As outlined in Section 4.4.5 this scenario is not considered representative of SWR WWTP as emissions are well in excess of any of the measured emissions at the plant. This scenario is included for comparative purposes only.

4.6.2 Proposed SWR WWTP

For the 2014 assessment of impacts Council have advised further set plant upgrades to those assessed in 2008/9. Essentially the next stage of upgrade will be to duplicate the SBR's and then ultimately a third lot of SBR's and additional sludge lagoons to get to ultimate design capacity. The staging plan allows operation of the existing pasveers as either extra sludge storage or part of the treatment depending upon the stage of development.

Odour concentrations from the proposed plant at ultimate capacity are at acceptable levels at approximate distances of 300 m for Scenario 1, 320 m for Scenario 2 and 450 m for Scenario 3. As outlined above Scenario 3 is included for comparative purposes only and is not considered further.

4.6.3 Opportunities for Odour Control if required

There is no suggestion in this report that any odour controls are needed at South West Rocks WWTP even for buffer distances of the order of 400 m which is representative of distances to the nearest existing residential receivers. However, should any further assessment work show that odour control at the plant are required to meet a certain buffer distances then such works could be implement to reduce odour impacts.

This report shows that the inlet works and sludge lagoons have the highest odour emissions per unit area, with the sludge lagoons being dominant based on their very large size compared to the inlet works.

As such any odour control investigation at South West Rocks WWTP would most likely target the sludge lagoons followed by the inlet works, given that the inlet works.

One method of odour control often used at WWTPs is to cover the sources of odour and extract foul air to some treatment facility eg. biofilter, chemical scrubber, carbon filters. This works well for sources such as inlet works where the air volumes being treated are low and there is typically no need for regular access of the process unit being treated. Generally covers do not work well for sources such as sludge lagoons, as they need to be accessed for emptying etc. Typically odour controls for sludge lagoons involve removing the lagoons and replacing them with some other form of sludge management eg. dewatering plants such as belt presses and centrifuges. Such solutions have been commonly applied to WWTPs with odour emission problems. They do, however, have operational implications for WWTPS and would needed to be investigated in close consultation with the plant operator.

4.6.4 Consideration of Odours from Plant Upsets / Malfunctions / Maintenance

The assessment of odours from wastewater treatment plants using modelling typically considers odours from normal plant operations, as has been assessed here.

Odours which are higher than normal operating odours can occur from time to time as a consequence of plant upsets, malfunctions or maintenance. In this regard for SWR WWTP Council have advised the following:

- Chemical spill (ad vised by Council to be assumed but never proven) which killed all biological activity in SBR's;
- Septicity of wastewater received at the plant;
- During wet weather the spare pasveer(s) are used as storm overflow and filled with raw sewage, until it can be pumped out back through the SBR's. This can create some odour depending upon how long the material stays in the pasveers.

Given the infrequency and short duration of such events it is not considered that this would influence the determination of plant buffer zones.

4.6.5 Best Estimate of Buffer Zone Requirements

The results of this odour study demonstrate that the buffer zone requirements for South West Rocks WWTP when upgraded and without any odour control measures range from between approximately 300 m to 320 m depending on odour emissions assumed for the plant. For the existing plant the recommended buffer is 150 m to 160 m consistent with the 2008/9 assessments.

To accurately determine the extent of the odour impact and therefore buffer zones requires certainty over WWTP odour emission rates. Odour emission rates are best determined from on-site measurements at the actual plant under investigation. Such measurements were collected at South West Rocks WWTP during Autumn 2008 and Summer 2009, and the results of odour modelling using this measured data, as well as high odour emissions assumed for SBRs and the centrifuge is that a 160 m buffer zone is required for the existing plant and 320 m for the upgraded WWTP, based on the 2014 upgrade concept.

5. Conclusion

5.1 Conclusions

A site-specific assessment of odour emissions from the South West Rocks WWTP for the existing and proposed future upgrade of the plant was conducted.

Meteorological data and worst-case measured odour emissions from the site were used in dispersion modelling and compared to the results of modelling using worst-case emissions data from the SWC odour database, which contains odour measurements from a variety of WWTPs around NSW. These scenarios were considered to adequately reflect the worst possible levels of odour emissions from the SWR WWTP.

Odour concentrations were found to be below the DECC guideline criterion of 2 OU/m^3 at a distance of approximately 150 to 160 m from the WWTP site for the existing plant and approximately 300 m to 320 m for the proposed arrangement, depending on the assumptions used in the modelling.

None of the scenarios considered the addition of any mitigation measures to reduce odour emissions; as such, potential odour concentrations may be reduced if required.

Appendix A. SEMA 2008 and 2009 Odour Sampling Reports

A.1 SEMA 2008 Report

Stephenson

Environmental Management Australia

DRAFT

Odour Assessment Survey

Sinclair Knight Merz

South West Rocks, NSW

Project No.:	4049/S13181/08
Date of Survey:	May 2008
Date of Issue:	May 2008

P W Stephenson

D Simanovic

Stephenson
Environmental Management Australia

Peter W Stephenson & Associates Pty Ltd
ACN 002 600 526 (Incorporated in NSW)
ABN 75 002 600 526

Newington Business Park
Unit 7/2 Holker Street
Newington NSW 2127 Australia
Tel: (02) 9737 9991
Fax: (02) 9737 9993
E-Mail: info@stephensonenv.com.au

ODOUR ASSESSMENT SURVEY

SINCLAIR KNIGHT MERZ

SOUTH WEST ROCKS, NSW

PROJECT NO.: 4049/S13181/08

DATE OF SURVEY: MAY 2008

DATE OF ISSUE: MAY 2008

P W STEPHENSON

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1 INTRODUCTION

Stephenson Environmental Management Australia (SEMA) was commissioned by Sinclair Knight Merz (SKM) to undertake an odour emission monitoring survey at the Macleay Water Sewage Treatment Plant (STP) in South West Rocks, New South Wales (NSW).

The scope of work undertaken was as follows:

- Conduct an odour survey at the STP for the six nominated locations.
- Prepare a brief report for SKM based on the findings of the survey.

The main objective of the work was to ascertain odour emission concentrations at the nominated locations within the STP.

The site test work was conducted on 22 May 2008.

1.1 PRODUCTION CONDITIONS

Macleay Water personnel advised the plant was operating under typical conditions on the day of testing, however acknodged that odour emissions are variable and change depending on the sewer catchment discharging to the STP.

The surface aerators installed on each Pasveer were working on their normal timing cycles. However, subsurface aerators were not operating. Sharon at Macleay Water STP advised that these subsurface aerators are only used during periods of elevated demand on STP, such as summer vacation periods.

2 EMISSION TEST RESULTS

2.1 INTRODUCTION

SEMA performed the sampling and analysis for flow, velocity, temperature and odour. SEMA is NATA accredited to ISO 17025 for all the sampling and analysis work defined above, except odour analysis, our accreditation number (No.) is 15043.

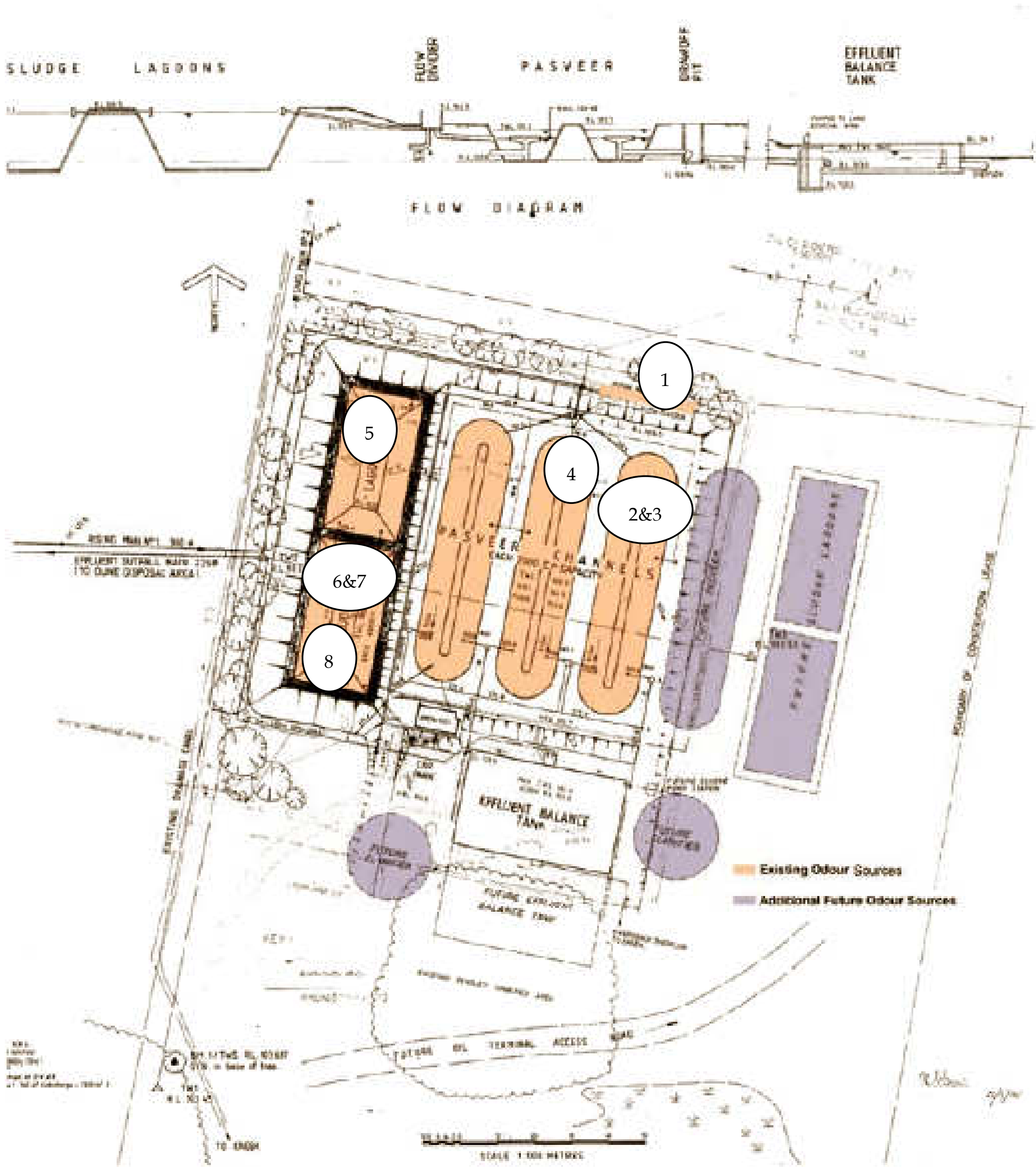
Odour Research Laboratories Australia (ORLA), a subsidiary of Peter W Stephenson and Associates Pty Ltd, completed the odour analysis, ORLA is NATA accredited to ISO17025 for this analysis, ORLA's accreditation No. is 15043. Results are reported in ORLA Report No. 4049/ORLA/01. Refer to Appendix A for Certificates of Analysis.

Figure 2-1 illustrates the site layout of the plant and the locations where samples were obtained.

The results of the current odour assessment survey are described in detail in Section 2.2. Table 2-1 summarises the test results and includes the temperatures and comments recorded during each sampling event.

The equilibrium odour hood flux rate was 6.42×10^{-4} metres per second (m/s) (5 litres per minute (L/min) sweep rate). Refer to Table 2-2 for Surface Odour Emission Rates (SOER).

FIGURE 2-1 SOUTH WEST ROCKS STP SITE LAYOUT



Key:

1	= Inlet
2 & 3	= Pasveer 1
4	= Pasveer 2
5	= Sludge Lagoon – North
6 & 7	= Sludge Lagoon – South (Disturbed)
8	= Sludge Lagoon – South (Undisturbed)

2.2 ODOUR EMISSION RESULTS

Odour samples were taken from eight nominated locations within the process of the STP. The sampling technique was as per the requirements of AS4323.3 utilising an equilibrium flux hood. Refer to Figure 2-1 for locations of samples within the STP.

Table 2-1 summarises the odour assessment test results which includes temperatures and comments at the time of sampling. Table 2-2 summarises the Surface Odour Emission Rate (SOER) for the eight nominated locations.

TABLE 2-1 SUMMARY OF ODOUR ASSESSMENT TEST RESULTS

Location	Date	Sample Time (hrs)	Temperature (°C)	Odour Units (ou)	Comments
Inlet	22/5/08	0955	22.0	279	Wind Speed 2.1m/s, Direction SSW
Pasveer 1 – Run 1	22/5/08	1040	19.3	60	Wind Speed 2.6m/s, Direction SSW
Pasveer 1 – Run 2	22/5/08	1125	19.2	27	Wind Speed 2.1m/s, Direction SSW
Pasveer 2	22/5/08	1155	16.7	27	Wind Speed 3.0m/s, Direction SSW
Sludge Lagoon – North	22/5/08	1225	17.6	65	Not much sludge at the bottom of lagoon, Wind Speed 1.8m/s, Direction SSW
Sludge Lagoon – South (Disturbed) Run 1*	22/5/08	1255	17.7	529	Wind Speed 1.9m/s, Direction SSW
Sludge Lagoon – South (Disturbed) Run 2	22/5/08	1325	17.7	259	Wind Speed 1.9m/s, Direction SSW
Sludge Lagoon – South (Undisturbed)	22/5/08	1345	17.3	305	Wind Speed 2.1m/s, Direction SSW

Note: Pasveer surface aerator working however subsurface aerator not working.

* Sharon @ Macleay Water advised Sludge Lagoon (Disturbed) was not functioning properly and have had problems in the past.

Key:

ou	=	odour units	°C	=	degrees Celsius
hrs	=	hours	SSW	=	South South West
m/s	=	metres per second			

TABLE 2-2 SUMMARY OF SOER TEST RESULTS

Sample Location	Temperature (°C)	Final Result to be Reported (ou)	Equilibrium Flux Hood Sweep Rate (5L/min) (m/s)	SOER (ou m/s) wet
Inlet	22.0	279	$6.42 * 10^{-4}$	0.1792
Pasveer 1 – Run 1	19.3	60	$6.42 * 10^{-4}$	0.0385
Pasveer 1 – Run 2	19.2	27	$6.42 * 10^{-4}$	0.0173
Pasveer 2	16.7	27	$6.42 * 10^{-4}$	0.0173
Sludge Lagoon – North	17.6	65	$6.42 * 10^{-4}$	0.0418
Sludge Lagoon – South (Disturbed) Run 1	17.7	529	$6.42 * 10^{-4}$	0.3398
Sludge Lagoon – South (Disturbed) Run 2	17.7	259	$6.42 * 10^{-4}$	0.1664
Sludge Lagoon – South (Undisturbed)	17.3	305	$6.42 * 10^{-4}$	0.1959

Key:

ou	=	odour units
SOER	=	Source Odour Emission Rate
$ou.m^3/s/m^2$ or (m/s)	=	odour units per cubic metre per second per square metre wet
m/s	=	metres per second
°C	=	degrees Celsius

3 CONCLUSIONS

SEMA completed the odour assessment survey in accordance with the scope of work as defined by Sinclair Knight Merz. The site work was performed 22 May 2008.

From the data presented and test work conducted during typical production cycles, Tables 3-1 summarises all the relevant test data.

TABLE 3-1 SUMMARY OF ODOUR ASSESSMENT TEST RESULTS

Sample Location	Final Result to be Reported (ou)	Equilibrium Flux Hood Sweep Rate (5L/min) (m/s)	SOER (ou m/s) wet
Inlet	279	$6.42 * 10^{-4}$	0.1792
Pasveer 1 – Run 1	60	$6.42 * 10^{-4}$	0.0385
Pasveer 1 – Run 2	27	$6.42 * 10^{-4}$	0.0173
Pasveer 2	27	$6.42 * 10^{-4}$	0.0173
Sludge Lagoon – North	65	$6.42 * 10^{-4}$	0.0418
Sludge Lagoon – South (Disturbed) Run 1	529	$6.42 * 10^{-4}$	0.3398
Sludge Lagoon – South (Disturbed) Run 2	259	$6.42 * 10^{-4}$	0.1664
Sludge Lagoon – South (Undisturbed)	305	$6.42 * 10^{-4}$	0.1959

Key:

ou = odour units

SOER = Source Odour Emission Rate

$ou.m^3/s/m^2$ or (m/s) = odour units per cubic metre per second per square metre wet

m/s = metres per second

^oC = degrees Celsius

4 TEST METHODS

4.1 EXHAUST GAS VELOCITY

(DECC NSW TM-2 and USEPA Method 12)

Velocity profiles were obtained across the utilising a Vane Anemometer.

4.2 EXHAUST TEMPERATURE

(DECC NSW TM-1 & 2, USEPA Method 2, Australian Standards AS 4323.1 and 4323.2)

The exhaust gas temperature was measured using a Digital thermometer (0-1200^{o}C) connected to a chromel/alumel (K-type) thermocouple probe.

4.3 ODOUR MEASUREMENT/DYNAMIC OLFACTOMETRY

(AS 4323.3 and OM-7 and OM-8)

Samples were collected in 30L Nalophane sampling bags which are enclosed in airtight plastic containers. Surface samples were collected utilising a "witches hat/equilibrium flux hoods" type hood as required in accordance with AS4323.3.

Odorous gas for analysis was drawn through a Teflon (PTFE) sample probe. The gas then passes through a Teflon (PTFE) tube connected to the Nalophane sampling bag. The sampling pump is connected to the airtight plastic container to provide a sample gas flow-rate of approximately 0.5 – 1.5 litres per minute. After the required volume has been sampled, the pump is stopped and the bag sealed with a stainless steel valve. Two samples were collected from each site.

Using a triangular forced choice olfactometer, the Nalophane bag of odour sample was dynamically diluted to various concentrations with dry odour free air.

The diluted sample was then presented to a panel of screened panellists as one of these airflows. The panellists then recorded if they could detect any odour and from which flow. The other two flows were discharging odour free air.

The odour is always presented to the panellists in ascending concentration; that is, from lower to higher concentration. The panellists are required at each dilution level to give a response as to what they are smelling from the flows (forced choice methodology). The response options for the panellists are:

'Guess'	Unable to determine which air flow contains the diluted odours
'Inkle'	Thinks that one of the flows August be different from the other two flows
'Detect' or 'Certain'	Is confident that one of the airflows smells different from the other two flows. Not necessarily able to say what the smell is.
'Recognise'	Thinks that one of the flows August be different from the other two flows and is able to: ▪ Assign a 'hedonic tone' (pleasantness scale number) to the odour ranging from –10 to 10 and/or ▪ Able to assign a character to the colour, as in 'it smells like …' *Note: that the Recognise level concentration and Hedonic Tone and Odour descriptors are obtained with the diluted odour, panellists are not exposed to the full strength odour.*

The percentage panel response and dilution levels used were then entered into a computer programme to determine the 50% panel response. This dilution level corresponds to the odour concentration of the sample.

Sampling and dilution lines are constructed from teflon, stainless or glass to prevent contamination of the sample.

The sampling and the dilution procedures used were in accordance with DECC NSW Method OM-7 and OM-8, which are based on Standards Association of Australia, AS4323.3.

4.3.1 ODOUR PANEL SELECTION

Odour panellists must meet certain criteria to qualify as and remain panellists. Their average sensitivity to n-Butanol must be between 20 and 80 parts per billion (ppb) and their variability in response to n-Butanol must be within a certain range.

Panellists are tested against n-Butanol before every panel session to ensure they are in compliance.

Panellists should not suffer from respiratory complaints, nor should they eat or smoke or drink anything but water during the half hour preceding or during the test period and their person and clothing should be odour free and have not been exposed to an odorous environment before testing.

4.3.2 ODOUR TERMINOLOGY

The odour level is expressed in odour units and for mixed odours is analogous to concentration expressed in parts per billion. The odour detection level is defined as the ratio of *the volume that a sample of odorous gas would occupy when diluted to the threshold of detection of that odour* to *the volume of the sample*. In simpler terms, the ratio indicated the number of dilutions necessary to reduce the odour to its threshold of detection or odour detection threshold. This ratio is expressed in odour units or number of dilutions to detection threshold. For example, a value of 2,000 odour units would mean the volume of the initial sample of odorous gas would need to be diluted 2,000 times before the odour would just be detectable to the average human nose, that is, at the odour detection threshold.

4.4 ACCURACY

All results are quoted on a dry basis. SEMA has adopted the following (Table 4-1) uncertainties for various stack testing methods.

TABLE 4-1 ESTIMATION OF MEASUREMENT UNCERTAINTY

Pollutant	Methods	Uncertainty
Velocity	AS4323.1, TM-2, USEPA 2a,2c,	5%+

Key:

\+ = The uncertainties quoted have been determined @ 95% level of Confidence level (i.e. by multiplying the repeatability standard deviation by a co-efficient equal to 1.96) (Source – Measurement Uncertainty)

Sources: *Measurement Uncertainty – implications for the enforcement of emission limits by Maciek Lewandowski (Environment Agency) & Michael Woodfield (AEAT) UK* www.cem2004.it/art/3_6.pdf

Technical Guidance Note (Monitoring) M2 Monitoring of stack emissions to air Environment Agency Version 3.1 June 2005.

APPENDIX A – CERTIFICATES OF ANALYSIS

A.2 SEMA 2009 Report

Stephenson
Environmental Management Australia

ODOUR ASSESSMENT SURVEY

SINCLAIR KNIGHT MERZ

SOUTH WEST ROCKS, NSW

PROJECT NO.: 4261/S15232/09

DATE OF SURVEY: 5 JANUARY 2009

DATE OF ISSUE: 26 FEBRUARY 2009

P W STEPHENSON

M BRECKO

Stephenson
Environmental Management Australia

Peter W Stephenson & Associates Pty Ltd
ACN 002 600 526 (Incorporated in NSW)
ABN 75 002 600 526

Newington Business Park
Unit 7/2 Holker Street
Newington NSW 2127 Australia
Tel: (02) 9737 9991
Fax: (02) 9737 9993
E-Mail: info@stephensonenv.com.au

ODOUR ASSESSMENT SURVEY

SINCLAIR KNIGHT MERZ

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PROJECT NO.:	**4261/S15232/09**
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P W STEPHENSON

M BRECKO

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1 INTRODUCTION

Stephenson Environmental Management Australia (SEMA) was commissioned by Sinclair Knight Merz (SKM) to undertake an odour emission monitoring survey at the Macleay Water Sewage Treatment Plant (STP) in South West Rocks, New South Wales (NSW).

The scope of work undertaken was as follows:

- Conduct an odour survey at the STP at eight nominated locations.
- Prepare a brief report for SKM based on the findings of the survey.

The main objective of the work was to ascertain odour emission concentrations at the nominated locations within the STP during typical summer holiday season peak loads.

The site test work was conducted on 5 January 2009.

1.1 PRODUCTION CONDITIONS

Macleay Water personnel advised the plant was operating under typical conditions on the day of testing. However, Macleay Water also acknowledged that odour emissions are variable and can change depending on the sewer catchment load discharging to the STP particularly during peak holiday periods.

The surface aerators installed on each Pasveer were working on their normal timing cycles. During this test the subsurface aerators were also operating on their normal timing cycles.

The cycle times for aeration on the Pasveers were automatically set for a 134 minute aeration followed by a 55 minute period to allow for settling and a further 32 minute period to allow for Decant. This cycle would then repeat itself.

The inlet works, as expected, had random peak flows of varying but short duration which required adopting a start and stop technique during odour sampling. These inlet odour samples were accumulated into a total single sample for later olfactometry analysis.

Sludge Lagoon 1 had a well formed crust and Sludge Lagoon 2 was still in the liquid phase.

2 EMISSION TEST RESULTS

2.1 INTRODUCTION

SEMA performed the sampling and analysis for flow, velocity, temperature and odour. SEMA is NATA accredited to ISO 17025 for all the sampling and analysis work defined above, except odour analysis, our accreditation number (No.) is 15043.

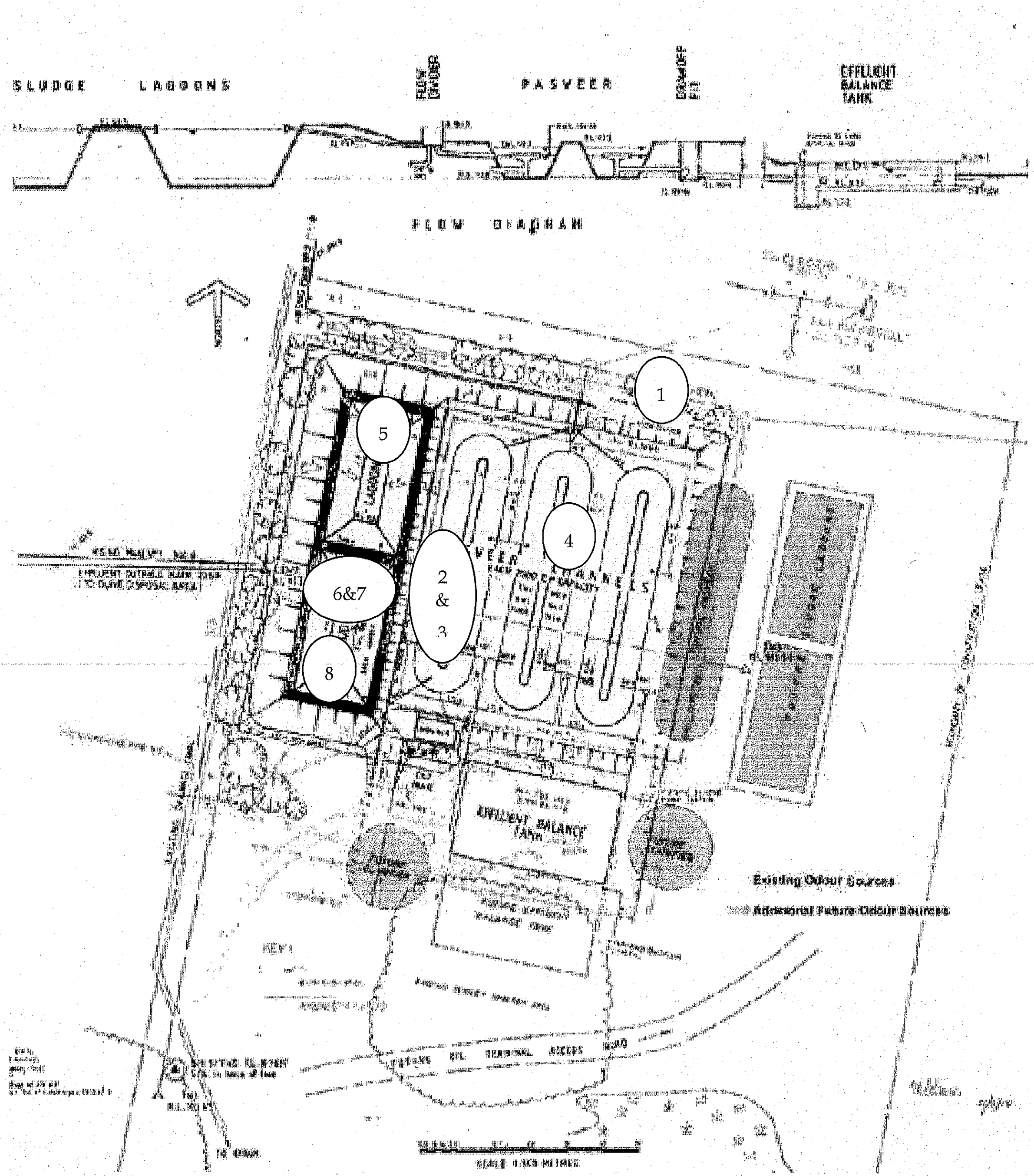
Odour Research Laboratories Australia (ORLA), a subsidiary of Peter W Stephenson and Associates Pty Ltd, completed the odour analysis, ORLA is NATA accredited to ISO17025 for this analysis, ORLA's accreditation No. is 15043. Results are reported in ORLA Report No. 4261/ORLA/01. Refer to Appendix A for Certificates of Analysis.

Figure 2-1 illustrates the site layout of the plant and the locations where samples were obtained.

The results of the current odour assessment survey are described in detail in Section 2.2. Table 2-1 summarises the test results and includes the temperatures and comments recorded during each sampling event.

The equilibrium odour hood flux rate was 6.42×10^{-4} metres per second (m/s) (5 litres per minute (L/min) sweep rate). Refer to Table 2-2 for Surface Odour Emission Rates (SOER).

FIGURE 2-1 SOUTH WEST ROCKS STP SITE LAYOUT



Key:

1	= Inlet
2 & 3	= Pasveer 1
4	= Pasveer 2
5	= Sludge Lagoon 2 – North End
6 & 7	= Sludge Lagoon 1 – South (Undisturbed & Disturbed)
8	= Sludge Lagoon 1 – North (Undisturbed)

2.2 ODOUR EMISSION RESULTS

Odour samples were taken from eight nominated locations within the process of the STP. The sampling technique was as per the requirements of AS4323.3 and DECC NSW OM-8 utilising an equilibrium flux hood. Refer to Figure 2-1 for locations of where samples were collected within the STP.

Table 2-1 summarises the odour assessment test results which includes temperatures and comments at the time of sampling. Table 2-2 summarises the Surface Odour Emission Rate (SOER) for the eight nominated locations.

TABLE 2-1 SUMMARY OF ODOUR ASSESSMENT TEST RESULTS

Location	Date	Sample Time (hrs)	Temperature (°C)	Odour Units (ou)	Comments
Inlet	5/1/2009	0845-0910	--	941	Stop Start technique used in the lower basin
Pasveer 1 – Aeration	5/1/2009	0658-0709	24.4	25	Sample taken on the South side of surface aerators in the direction of the flow.
Pasveer 1 – Settlement	5/1/2009	0759-0809	26.5	23	Sample taken at least 15 minutes after Surface aerators turned off
Pasveer 2 - Aeration	5/1/2009	0801-0810	24.6	35	Sample taken on the North side of surface aerators in the direction of the flow.
Sludge Lagoon 2– North End – Liquid Phase	5/1/2009	0902-0912	31.3	77	Sludge Lagoon 2 was completely in Liquid Phase
Sludge Lagoon 1– South End – Undisturbed	5/1/2009	0950-0959	33.2	1,106*	This result leads SEMA to believe that the crust was disturbed
Sludge Lagoon 1– North End – Disturbed	5/1/2009	1001-1010	35.6	385	Sludge Lagoon 1 had a good thick crust over the whole lagoon
Sludge Lagoon 1–North End - Undisturbed	5/1/2009	1032-1042	37.7	385	Sludge Lagoon 1 had a good thick crust over the whole lagoon

Note: * denotes that SEMA believes the crust was disturbed during sampling

Key:

ou	=	odour units	°C	=	degrees Celsius
hrs	=	hours	m/s	=	metres per second

TABLE 2-2 SUMMARY OF SOER TEST RESULTS

Sample Location	Final Result to be Reported (ou)	Equilibrium Flux Hood Sweep Rate (5L/min) (m/s)	SOER (ou m/s) wet
Inlet	941	$6.42 * 10^{-4}$	0.016
Pasveer 1 – Aeration	25	$6.42 * 10^{-4}$	0.015
Pasveer 1 - Settlement	23	$6.42 * 10^{-4}$	0.022
Pasveer 2 - Aeration	35	$6.42 * 10^{-4}$	0.049
Sludge Lagoon 2– North End – Liquid Phase	77	$6.42 * 10^{-4}$	0.605
Sludge Lagoon 1– South End – Undisturbed	1,106*	$6.42 * 10^{-4}$	0.711
Sludge Lagoon 1– North End – Disturbed	385	$6.42 * 10^{-4}$	0.247
Sludge Lagoon 1–North End - Undisturbed	385	$6.42 * 10^{-4}$	0.247

Key:

*	=	denotes that SEMA believes the lagoon crust was disturbed
°C	=	degrees Celsius
L/min	=	Litres per minute
m/s	=	metres per second
ou	=	odour units
ou.m^3/s/m^2 or (m/s)	=	odour units per cubic metre per second per square metre wet
SOER	=	Source Odour Emission Rate

3 CONCLUSIONS

SEMA completed the odour assessment survey in accordance with the scope of work as defined by Sinclair Knight Merz. The site work was performed on 5 January 2009.

From the data presented and test work conducted during typical summer peak cycles, Tables 3-1 summarises all the relevant test data.

TABLE 3-1 SUMMARY OF ODOUR ASSESSMENT TEST RESULTS

Sample Location	Final Result to be Reported (ou)	Equilibrium Flux Hood Sweep Rate (5L/min) (m/s)	SOER (ou m/s) wet
Inlet	941	$6.42 * 10^{-4}$	0.016
Pasveer 1 - Aeration	25	$6.42 * 10^{-4}$	0.015
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Sludge Lagoon 2– North End - Liquid Phase	77	$6.42 * 10^{-4}$	0.605
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Key:

*	=	denotes that SEMA believes the lagoon crust was disturbed.
°C	=	degrees Celsius
L/min	=	litres per minute
m/s	=	metres per second
ou	=	odour units
$ou.m^3/s/m^2$ or (m/s)	=	odour units per cubic metre per second per square metre wet
SOER	=	Source Odour Emission Rate

4 TEST METHODS

4.1 EXHAUST GAS VELOCITY

(DECC NSW TM-2 and USEPA Method 12)

Velocity profiles were obtained across the utilising a Vane Anemometer.

4.2 EXHAUST TEMPERATURE

(DECC NSW TM-1 & 2, USEPA Method 2, Australian Standards AS 4323.1 and 4323.2)

The exhaust gas temperature was measured using a Digital thermometer (0-1200°C) connected to a chromel/alumel (K-type) thermocouple probe.

4.3 ODOUR MEASUREMENT/DYNAMIC OLFACTOMETRY

(AS 4323.3 and OM-7 and OM-8)

Samples were collected in 30L Nalophane sampling bags which are enclosed in airtight plastic containers. Surface samples were collected utilising a "witches hat/equilibrium flux hoods" type hood as required in accordance with AS4323.3.

Odorous gas for analysis was drawn through a Teflon (PTFE) sample probe. The gas then passes through a Teflon (PTFE) tube connected to the Nalophane sampling bag. The sampling pump is connected to the airtight plastic container to provide a sample gas flow-rate of approximately 0.5 - 1.5 litres per minute. After the required volume has been sampled, the pump is stopped and the bag sealed with a stainless steel valve. Two samples were collected from each site.

Using a triangular forced choice olfactometer, the Nalophane bag of odour sample was dynamically diluted to various concentrations with dry odour free air.

The diluted sample was then presented to a panel of screened panellists as one of these airflows. The panellists then recorded if they could detect any odour and from which flow. The other two flows were discharging odour free air.

The odour is always presented to the panellists in ascending concentration; that is, from lower to higher concentration. The panellists are required at each dilution level to give a response as to what they are smelling from the flows (forced choice methodology). The response options for the panellists are:

'Guess'	Unable to determine which air flow contains the diluted odours
'Inkle'	Thinks that one of the flows may be different from the other two flows
'Detect' or 'Certain'	Is confident that one of the airflows smells different from the other two flows. Not necessarily able to say what the smell is.
'Recognise'	Thinks that one of the flows may be different from the other two flows and is able to: ▪ Assign a 'hedonic tone' (pleasantness scale number) to the odour ranging from -10 to 10 and/or ▪ Able to assign a character to the colour, as in 'it smells like …' *Note: that the Recognise level concentration and Hedonic Tone and Odour descriptors are obtained with the diluted odour, panellists are not exposed to the full strength odour.*

The percentage panel response and dilution levels used were then entered into a computer programme to determine the 50% panel response. This dilution level corresponds to the odour concentration of the sample.

Sampling and dilution lines are constructed from teflon, stainless or glass to prevent contamination of the sample.

The sampling and the dilution procedures used were in accordance with DECC NSW Method OM-7 and OM-8, which are based on Standards Association of Australia, AS4323.3.

4.3.1 ODOUR PANEL SELECTION

Odour panellists must meet certain criteria to qualify as and remain panellists. Their average sensitivity to n-Butanol must be between 20 and 80 parts per billion (ppb) and their variability in response to n-Butanol must be within a certain range.

Panellists are tested against n-Butanol before every panel session to ensure they are in compliance.

Panellists should not suffer from respiratory complaints, nor should they eat or smoke or drink anything but water during the half hour preceding or during the test period and their person and clothing should be odour free and have not been exposed to an odorous environment before testing.

4.3.2 ODOUR TERMINOLOGY

The odour level is expressed in odour units and for mixed odours is analogous to concentration expressed in parts per billion. The odour detection level is defined as the ratio of *the volume that a sample of odorous gas would occupy when diluted to the threshold of detection of that odour* to *the volume of the sample*. In simpler terms, the ratio indicated the number of dilutions necessary to reduce the odour to its threshold of detection or odour detection threshold. This ratio is expressed in odour units or number of dilutions to detection threshold. For example, a value of 2,000 odour units would mean the volume of the initial sample of odorous gas would need to be diluted 2,000 times before the odour would just be detectable to the average human nose, that is, at the odour detection threshold.

4.4 ACCURACY

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TABLE 4-1 ESTIMATION OF MEASUREMENT UNCERTAINTY

Pollutant	Methods	Uncertainty
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Key:

The uncertainties quoted have been determined @ 95% level of Confidence level (i.e. by multiplying the repeatability standard deviation by a co-efficient equal to 1.96) (Source – Measurement Uncertainty)

Sources: *Measurement Uncertainty – implications for the enforcement of emission limits by Maciek Lewandowski (Environment Agency) & Michael Woodfield (AEAT) UK www.cem2004.it/art/3_6.pdf*

Technical Guidance Note (Monitoring) M2 Monitoring of stack emissions to air Environment Agency Version 3.1 June 2005.

APPENDIX A – CERTIFICATES OF ANALYSIS

Odour Research Laboratories Australia

A Division of Peter W. Stephenson & Associates Pty Ltd
ACN 002 600 526 (Incorporated in NSW)
ABN 75 002 600 526

Newington Business Park
Unit 7/2 Holker Street
Newington NSW 2127 Australia
Tel: (02) 9737 9991
Fax: (02) 9737 9993
E-Mail: mbrecko@orla.com.au

Olfactometry Test Report

The measurement was commissioned by SEMA on behalf of:

Client	Organisation:	SKM
	Address:	PO Box 2147, Dangar NSW 2309
	Contact:	Matt Davies
	Sampling Site:	South West Rocks – WWTP
	Telephone:	9032 1817
	Facsimile:	9928 2502
	Email:	mdavies@skm.com.au
Project	ORLA Report Number:	4261/ORLA/01
	Project Manager:	Peter Stephenson
	Testing operator:	Michael Brecko
	ORLA Sample number(s):	1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885
	SEMA Sample number(s):	716300, 716301, 716302, 716303, 716304, 716305, 716306, 716307
Order	Analysis Requested:	Odour Analysis
	Order requested by:	SEMA on behalf of SKM
	Date of order:	6 January 2009
	Order number:	2235
	Telephone:	02 9737 9991
	Signed by:	Michael Brecko
	Order accepted by:	Michael Brecko

NATA accredited laboratory number 15043.
Accredited for Compliance with ISO/IEC 17025.
This report cannot be reproduced unless in full.

Investigated Item	Odour concentration in odour units 'ou' determined by Sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Analysis Method	The samples were analysed in accordance with AS/NZS4323.3:2001.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification) sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian Standard 'Determination of Odour Concentration by Dynamic Olfactometry AS/NZS4323.3:2001. The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for n-butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Instrument Used	The Olfactometer used during this testing session was: AC'SCENT International Olfactometer
Measuring Range	The measuring range of the AC'SCENT International olfactometer is $2^4 \leq \chi \leq 2^{16}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained between ± 3°C.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.05$ in accordance with the Australian Standard AS/NZS4323.3:2001. AC'SCENT International Olfactometer: $r = 0.0106$ (March 2008) Compliance - Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.20$ in accordance with the Australian Standard AS/NZS4323.3:2001. AC'SCENT International Olfactometer: $A = 0.069$ (March 2008) Compliance - Yes
Lower Detection Limit (LDL)	The LDL for the AC'SCENT International Olfactometer has been determined to be 15 ou
Traceability	The measurements have been performed using standards for which the traceability to the national standard has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen.

21 January 2009

Michael Brecko
Laboratory Manager

Odour Olfactometry Results – 4261/ORLA/01

Sample Location	Sample ID No.	Sampling Date & Time	ORLA Sample No.	Analysis Date & Time (Completed)	Panel Size	Valid ITEs	Sample Pre-Dilution	Sample Odour Concentration (ou) [1]	Sample Odour Concentration (ou) [2]	Odour Character & Hedonic Tone ^ +
Sample ID: Pasveer 1 – Aeration	716300	5/1/09 7:09	1878	6/1/09 10:27	4	8	Nil	25	25	Sweet-rotting fruit, smokey, cardboard, musty with solvent overtone, to weak to recognise (-1)^
Sample ID: Pasveer 1 – Settlement	716301	5/1/09 8:09	1879	6/1/09 10:45	4	8	Nil	23	23	Rubbish, smokey, cardboard, musty with solvent overtone, to weak to recognise (-1.5)^
Sample ID: Pasveer 2 - Aeration	716302	5/1/09 8:10	1880	6/1/09 11:01	4	8	Nil	35	35	Landfill, rubbish, smokey, beer, hops, to weak to recognise (-1.8)^
Sample ID: Sludge Lagoon 2 – Nth End – Liquid Phase	716303	5/1/09 9:12	1881	6/1/09 11:21	4	8	Nil	77	77	Sewer, burnt smell, gaseous, cardboard, faint musty smell, to weak to recognise (-2.8)^
Sample ID: Inlet	716304	5/1/09 9:45	1882	6/1/09 11:45	4	8	Nil	941	941	Sewer, rotten eggs, gaseous, gas from mangroves-swamp (-4)^

Odour Olfactometry Results – 4261/ORLA/01

Sample Location	Sample ID No.	Sampling Date & Time	ORLA Sample No.	Analysis Date & Time (Completed)	Panel Size	Valid ITEs	Sample Pre-Dilution	Sample Odour Concentration (ou) [1]	Sample Odour Concentration (ou) [2]	Odour Character & Hedonic Tone^ +
Sample ID: Sludge Lagoon 1 – Nth End – Undisturbed Crust	716305	5/1/09 9:59	1883	6/1/09 12:03	4	8	Nil	1,106	1,106	Sulphur, rotten eggs, smokey, gaseous, rubbish, sewer (-4)^
Sample ID: Sludge Lagoon 1 – Sth End – Disturbed Crust	716306	5/1/09 10:10	1884	6/1/09 12:25	4	8	Nil	385	385	Rotten eggs, mangroves-swamp, smokey, sewer (-2.5)^
Sample ID: Sludge Lagoon 1 – Sth End – Undisturbed Crust	716307	5/1/09 10:42	1885	6/1/09 12:45	4	8	Nil	385	385	Swamp gas, gaseous, rotten eggs, sewer (-4.8)^

Odour Panel Calibration Results - 4261/ORLA/01

Reference Odorant	ORLA Sample No.	Concentration of Reference Gas (ppm)	Reference Gas Measured Concentration (ou)	Panel Average Measured Concentration (ppb) [3]	Does this panel calibration measurement comply with AS/NZS4323.3:P2001 (Yes/No) [4]
n-butanol	1877	60.7	871	69.7	Yes

Comments: All samples were collected by Stephenson Environmental Management Australia and analyses by Odour Research Laboratories Australia at their Sydney Laboratory.

Notes from Odour Olfactometry Results:

1 Sample Odour Concentration: as received in the bag

2 Sample Odour Concentration: allowing for pre-dilution

3 Panel Average Measured Concentration: indicates the sensitivity of the panel for the session completed

4 Target Range for reference gas n-butanol is $20 \leq \chi \leq 80$ ppb and compliance with AS/NZ4323.3:2001 is based on the individuals rolling average and not on the panel average measured concentration. Panellist Rolling Average: AC = 72.9, CS = 69.8, PR = 64.0, TT = 67.6

^ denotes the Average Hedonic Tone: describes the pleasantness of the odour being presented where (+5) represents Very Pleasant, (0) represents Neutral and (-5) represents Very Unpleasant and has been derived from the panellist responses at the recognition threshold.

+ This value is not part of our NATA Scope of Accreditation and AS4323.3

Appendix B. Meteorological Data – Quality Check

Stability Class by Time of Day – South West Rocks STP Meteorological Station

Time of Day	Stability Class						
	A	B	C	D	E	F	Total
1				71	61	216	348
2				67	59	222	348
3				60	61	227	348
4				59	65	224	348
5				47	63	238	348
6				42	59	247	348
7	40	17	11	43	51	186	348
8	134	48	45	38	15	68	348
9	187	70	44	47			348
10	180	74	43	51			348
11	156	84	51	57			348
12	175	60	52	61			348
13	177	53	48	70			348
14	182	48	51	67			348
15	190	46	42	70			348
16	186	44	47	71			348
17	182	44	45	77			348
18	163	49	53	83			348
19	114	31	38	96	9	60	348
20	32	10	9	104	43	150	348
21				102	48	198	348
22				92	58	198	348
23				79	56	213	348
24				75	59	214	348
Total	2098	678	579	1629	707	2661	8352

Stability Class by Wind Speed – South West Rocks STP Meteorological Station

Wind Speed	Stability Class						
	A	B	C	D	E	F	Total
0.5	220	17	1	8	41	1065	1352
1	341	38	24	33	178	857	1471
1.5	488	65	27	27	173	401	1181
2	478	94	72	47	142	218	1051
2.5	381	101	103	111	72	96	864
3	190	114	103	206	25	24	662
3.5		177	87	210	12		486
4		72	54	224	21		371
4.5			52	210	21		283
5			36	183	22		241
6			20	221			241
7				126			126
8				21			21
9				2			2