The existing Rathmines No. 6 WWPS is also located in relatively close proximity (just over 200m) to Kilaben Bay and the un-named watercourses, near where the watercourses enter the bay.

6.3.2.1 Groundwater

A number of groundwater monitoring wells exist at the site currently, and are shown in **Figure 5.5**. Four bores sit at depths ranging from 5.0 to 7.5m (installed in 1998), and the remaining bores sit at depths of between 20m and 40m (installed in 2006) (LMCC, 2006).

The bores are monitored in accordance with the conditions set out in M2 of the existing EPL, which includes measurement of each of the groundwater parameters listed in **Table 6.7**. **Table 6.7** shows the range of groundwater quality recorded within the five bores based on the Annual Returns from 2008 to 2010.

Table 6.7: Recorded Groundwater Quality Range at the AWMF

Parameter	Units	Recorded Readings^	
		Lowest	Highest
Alkalinity (as calcium carbonate)	mg $CaCO_3$/L	0.5	806
Aluminium	mg/L	0.015	173
Ammonia	mg/L	<LOR	84.9
Arsenic	mg/L	0.0005	1.94
Barium	mg/L	0.0002	1.54
Benzene	mg/L	<LOR	<LOR
BOD	mg/L	<LOR	590
Cadmium	mg/L	<LOR	0.087
Calcium	mg/L	3	50
Chloride	mg/L	252	3030
Chlorinated volatile compounds	mg/L	<LOR	0.23
Chromium (hexavalent)	mg/L	<LOR	<LOR
Chromium (total)	mg/L	<LOR	0.116
Cobalt	mg/L	<LOR	0.048
Conductivity	µS/cm	1290	9200
Copper	mg/L	0.001	0.049
Ethyl benzene	mg/L	<LOR	<LOR
Fluoride	mg/L	<LOR	1.14
Iron	mg/L	<LOR	258
Lead	mg/L	0.0005	0.115
Magnesium	mg/L	23	215
Manganese	mg/L	0.08	1.94
Mercury	mg/L	<LOR	0.0005
Nitrate	mg/L	<LOR	0.24

Parameter	Units	Recorded Readings^	
		Lowest	Highest
Organochlorine pesticides	mg/L	<LOR	1
Organophosphate pesticides	mg/L	<LOR	0.016
PCBs	mg/L	<LOR	<LOR
pH	pH	4.75	6.53
Phosphate	mg/L	<LOR	0.01
Polycyclic aromatic hydrocarbons	mg/L	<LOR	0.008
Potassium	mg/L	7	74
Sodium	mg/L	30	1770
Sulfate	mg/L	0.04	1430
Toluene	mg/L	<LOR	0.003
Total dissolved solids	mg/L	151	8050
Total organic carbon	mg/L	<LOR	150
Total petroleum hydrocarbons	mg/L	<LOR	190
Total Phenolics	mg/L	<LOR	0.37
Zinc	mg/L	0.015	0.148

^ Readings across Monitoring Points 1 to 5, which monitor groundwater quality at the AWMF site, from the 2008, 2009 and 2010 Annual Returns under the EPL.

Monitoring frequency varies depending on the parameter, as detailed under condition M2 of the EPL, but is generally quarterly or yearly.

Overall, groundwater in the area has variable quality, as shown in **Table 6.7**; however, there is no indication of any groundwater contamination that has occurred from the operations of the landfill (LMCC, 2006). Annual Returns from 2008 to 2010 do not comprise any non-compliances in terms of groundwater quality. However, groundwater quantity non-compliances were present in each of the Annual Returns due to a lack of groundwater flows being present in a number of the groundwater wells. This meant that in several instances groundwater monitoring could not be undertaken. In some instances it took several years for the bores to start to provide enough water to constitute a sample (LMCC, 2006).

Geotechnique (2011) did not encounter groundwater or seepage to test pit termination depths up to 1.6m and borehole refusal depths of 3.0m in all boreholes except BH4, where groundwater seepage was noted at a depth of 4.0m. BH4 was located adjacent to a dam and groundwater level noted in this borehole corresponds approximately to the level of water in the dam (see **Figure 6.3** for test pit and borehole locations). Furthermore, Geotechnique (2011) noted that fluctuations in the level of groundwater might occur due to variations in rainfall and/or other factors not evident during drilling.

6.3.2.2 Stormwater

The existing AWMF site is divided into four drainage sub-catchments denoted on **Figure 6.7** as Sub-catchments 1, 2, 3 and 4. Sub-catchment 4 drains to sediment Basin 2, while Sub-catchments 1 and 2 drain to sediment Basin 5. Basin 5 spills to Basins 3 and 4, which also receive runoff from Sub-catchment 3. Overflows from sediment Basins 2 and 4 are directed towards the on-site un-named watercourse via surface drains and these drains discharge stormwater approximately 30m from the centreline of the waterway.

Any taking of water from surface sources (such as for amenities or wheel wash facilities) must be authorised by an access licence under the *Water Management Act 2000*. Stormwater runoff from the landfilled areas is currently diverted to the existing sediment basins for storage. These flows may then be utilised for irrigation on any landfilled area within the facility (spray irrigation often in relation to dust suppression activities) but must not be used on non-landfilled areas, in accordance with the EPL.

Under the existing EPL, LMCC are required to monitor four stormwater sites for the AWMF, namely Sites 6, 7, 8 and 9 (shown in **Figure 6.7**). These sites are monitored in accordance with the conditions set out in M2 of the existing EPL, which includes the measurement of the same parameters as listed for groundwater in **Section 6.3.2.1**. Monitoring frequency varies depending on the parameter, as detailed under condition M2 of the EPL, but is generally quarterly or yearly. Annual reports that detail the results of the monitoring are issued to OEH in accordance with the existing EPL. Results show that stormwater in the area has variable quality.

In accordance with the existing EPL, the 100 percentile concentration limit for total suspended solids (TSS) at monitoring sites 6 and 7 is 50 mg/L. Exceedances of the concentration limits for TSS at these sites are permitted whenever a wet weather overflow is occurring due to stormwater events greater than or equal to a 90th percentile 5 day rainfall duration.

Stormwater monitoring data for TSS, TN and TP from 2008 to 2010 for Sites 6 and 7, within the existing sediment basins at the site, is provided in **Appendix G**.

6.3.2.3 Surface Water

“Surface water” is runoff at the site that is *diverted around* the landfilled areas. Under the current EPL surface drainage on non-landfilled areas must be diverted away from any area where waste is being or has been landfilled for all storm events less than or equal to a 10 year ARI. Surface water diversions are shown in **Figure 5.5**.

Lake Macquarie City Council

Existing Sub-Catchments and Sediment Basins

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- Site Boundary
- Stormwater Quality Monitoring Sites
- Creekline
- 2m Topographic Contours
- Leachate Pond
- Sediment Basin
- ExistingSubCatchments
- Cadastre

N W E S

FIGURE 6.7

1:5,000 Scale at A4

Metres

0 25 50 100 150 200

Cardno

Data Source: Geoscience Australia
Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6007_ExistingSubcatchments.mxd 02
Imagery supplied by LMCC and associated third party suppliers

Water Quality (MUSIC Modelling)

A MUSIC model was developed to investigate stormwater runoff and its quality from the AWMF site under existing and worst case scenario expansion conditions (see **Appendix G** for condition details). Capped conditions were not modelled as runoff following capping is not expected to contain high levels of pollutants as the landfill operations have ceased and re-vegetation would have occurred.

Appendix G contains details of model inputs used, such as rainfall and evaporation data. The total landfill area under existing conditions is 15.35ha. The MUSIC model only considers the direct landfill area for each scenario since runoff generated outside of the landfill area is diverted around the landfill and is conveyed by surface drains to the on-site un-named watercourse.

Results of the MUSIC modelling for existing conditions are presented in **Section 6.3.3** for easier comparison with worst case scenario expansion conditions.

Water Quantity (Flood Modelling)

A qualitative assessment of flood impact due to the proposed expansion of the AWMF was undertaken using a hydrological model (xprafts model) for existing, capped and natural (unmodified) conditions.

Sub-catchment attributes under existing and capped conditions for flood modelling and also expansion conditions for MUSIC modelling are provided in **Appendix G**, along with details of xprafts model inputs. The total landfill area under capped conditions will be 23.92ha, and this was also adopted for natural conditions to allow comparison between results.

Results of the flood modelling for existing conditions are discussed in **Section 6.3.3** in comparison with results for capped and natural pre-development conditions.

6.3.3 Potential Impacts

6.3.3.1 Construction Phase

Construction works at the AWMF site could potentially impact on water quality downstream in the un-named watercourses if appropriate temporary stormwater runoff management measures are not implemented. Similarly construction works along the sewer pipeline route could also impact downstream water quality, particularly when trenching in the vicinity of the culverts under Wilton Road.

Trenching works along the access road leading to Rathmines No. 6 WWPS will also be in relatively close proximity to the waters of Kilaben Bay, hence could potentially have downstream impacts on the waters of the bay if appropriate mitigation measures are not implemented.

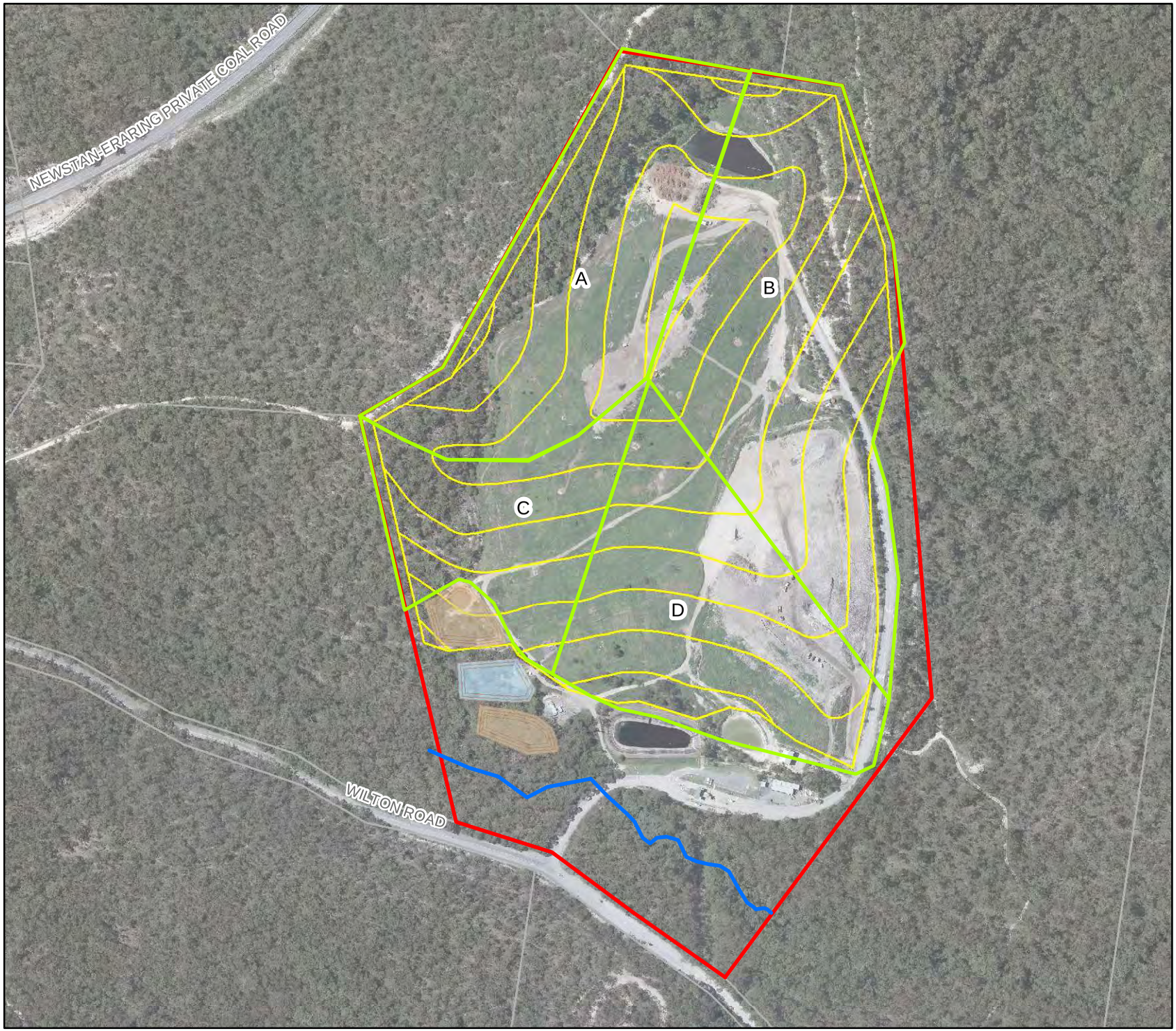
No groundwater extraction is proposed as part of the works, and any water required (such as for amenities or wheel wash facilities) is proposed to be sourced from the mains supply. Groundwater measurements in boreholes and test pits during field works indicated that the depth to groundwater level is likely to be more than 3.0m from the existing ground surface, except in the vicinity of the dams. Therefore, the only proposed emplacement excavation area where groundwater inflow is likely to occur during excavation for the new landfill cells is in the vicinity of the existing sediment basin in the north of the site. It is also likely that groundwater may be encountered during the excavation of the proposed sewer pipeline route, particularly in the lower lying coastal areas near Rathmines No. 6 WWPS and in the vicinity of the culvert crossing under Wilton Road. It should be noted that fluctuations in the level of groundwater and/seepage might occur due to variations in rainfall and/or other factors.

6.3.3.2 Operational Phase

Under proposed expansion conditions at the AWMF site, the existing cell boundaries will be re-aligned and extended laterally and increased in height in Areas A and B, while in Area C the landfill will be increased in height only. Under expansion conditions the AWMF site will be divided into 11 sub-catchments, A1 to A3, B1 to B4 and C1 to C4, as shown on **Figure 6.9**. Each of the cells will be progressively excavated and filled, as discussed in **Section 6.4.3.2**. The total landfill area under expansion conditions is 20.95ha.

Surface water diversion and stormwater management infrastructure will be constructed at the AWMF site to manage surface drainage so that the landfilled and non-land-filled areas remain separated (see **Figure 5.5**). The existing Sediment Basin 2 in the south of the site will be expanded to increase its capacity. It is proposed to reconstruct and consolidate existing sediment Basins 3, 4 and 5 into two new sediment basins (re-numbered Basins 1 and 3) to treat stormwater runoff from the expanded landfill area (see **Figure 5.5**). The modification will utilise available space in order to maximise the size of the stormwater management system on the site, with details of the proposed sediment basins provided in **Appendix G**. Overflows will be permitted to occur from sediment Basins 2 and 3 during expansion, if required, for events greater than the 10 Year ARI, in accordance with the existing EPL. Under capped conditions the expanded AWMF site will be broadly delineated based on the design contours under capped conditions into four sub-catchments, Areas A, B, C and D, as shown on **Figure 6.8**. The capped landfill will be a cone shape with eastern and western sub-catchments draining to their respective sediment basins, as shown on **Figure 6.8**.

Clean surface waters diverted around the landfill area would be conveyed in table drains, which would discharge runoff towards the on-site un-named watercourse via rock lined level spreaders, in order to reduce erosion on site. Note that no outlet structures are proposed within the un-named watercourse.



Lake Macquarie City Council

Proposed Sub-Catchments Under Capped Conditions

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- Site Boundary
- Creekline
- Proposed Sub-Catchments
- Proposed Leachate Pond
- Proposed Sediment Basin
- Cadastre

N
W E
S

FIGURE 6.8

1:5,000 Scale at A4

Metres

0 25 50 100 150 200

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6008_ProposedSubcatchments.mxd 02
Imagery supplied by LMCC and associated third party suppliers

Water Quality (MUSIC Modelling)

The results of the MUSIC modelling are summarised in **Table 6.8**. The estimated pollutant reductions exceed the DECC (2007a) environmental targets for stormwater pollutants, which recommends an 85%, 65% and 45% reduction in average annual exports of TSS, TP and TN, respectively. Hence, it is concluded that the treatment train to be implemented as part of the expansion of the AWMF site will achieve pollutant capture rates equal or better than that currently achieved under existing conditions.

Table 6.8: MUSIC Modelling Results for Stormwater Runoff Under Existing and Expansion Conditions

Parameter	Source Runoff	Discharge from AWMF Site	Reduction
Existing Conditions			
Flow (ML/y)	42.5	39.7	6%
TSS (kg/y)	18,800	1,020	95%
TP (kg/y)	28.2	5.52	80%
TN (kg/y)	204	111	46%
Expansion Conditions			
Flow	57.9	53.3	8%
TSS	26,200	1,370	95%
TP	38.6	7.51	81%
TN	266	128	52%

Water Quantity (Flood Modelling)

The proposed expansion will increase the landfill footprint and steepen the slope of the capped surface when compared with existing surface gradients in Areas A and B. These modifications will generate higher peak runoff than under existing conditions and there would be some expected increase in flood levels as a result. The xprafts model was run for the 1 and 2 year ARI events to assess the impact of the proposed expansion on runoff from frequent storms and the 100 year ARI event was run to assess the impact of the proposed expansion on runoff under large infrequent storms. Hydrographs for each of the events modelled are provided in **Appendix G**.

As the catchment areas under capped conditions are 56% greater than under existing conditions, there is a slight increase in the peak flows and the flow durations under capped conditions in comparison with existing conditions, as shown in the hydrographs in **Appendix G**. However, it should be noted that these increases under capped conditions still do not exceed flood levels under natural pre-development conditions. It is therefore concluded that there will be negligible impact on the on-site watercourse as a result of the proposed expansion.

Conveyance of the 10 year ARI peak flows to the on-site stormwater channels will be required during the operational phase of the landfill and under capped conditions. Open channels will be required to convey stormwater runoff to the sediment basins.

The sizing of the channels was undertaken based on the estimated 10 year ARI peak flows under capped conditions. The estimated peak 10 year ARI flows from each sub-catchment under capped conditions are summarised in **Table 6.9** along with indicative required channel sizes.

Table 6.9: Estimated Peak 10 Year ARI Flows under Capped Conditions and Indicative Dimensions of Required Open Channels

Sub-catchment	Peak Flow (m3/s)	Indicative Dimensions for Open Channels				
		Required Capacity (m^3/s)	Indicative Bed Slope (%)	Base Width (m)	Top Width (m)	Depth (m)
A	1.4	1.4	2	1.2	2.2	0.5
B	1.8	1.8	3	1.4	2.4	0.5
C	1.1	2.5	10	1	2	0.5
D	1.1	2.9	7	1.4	2.4	0.5

6.3.4 Mitigation Measures

The following provides an indication of recommended measures to mitigate negative impacts on water quality and hydrology as a result of the project. These mitigation measures address both the construction (**Section 6.3.4.1**) and operational phases (**Section 6.3.4.2**), and are considered to adequately address any negative impacts on water and hydrology associated with the proposal.

6.3.4.1 Construction Phase

Any potential impacts downstream on the un-named watercourses and the waters of Kilaben Bay will be mitigated through the implementation of temporary stormwater quantity and quality management measures during construction at the AWMF site and along the sewer pipeline route. These measures may include the installation of silt curtains, hay bale filters, surface water and stormwater diversions, etc. Many of these will constitute erosion and sediment control devices and as such will be specified by the Contractor in the ESCP. Other measures specifically to protect water quality and quantity will be specified in a *Stormwater Management Plan*, to be prepared and implemented by the Contractor during the works.

Runoff will continue to be managed separately, based on the source of the runoff. Surface water runoff from non-landfilled areas will continue to be diverted away from any area where waste is being or has been landfilled, whilst stormwater runoff from any landfilled area will continue to be diverted to the existing sediment basins for storage.

Riparian corridors form a transition zone between terrestrial and aquatic environments. Works in the vicinity of the unnamed watercourse in the southern portion of the site should be undertaken in accordance with *Controlled Activities: Guidelines for Riparian Corridors* (NSW Office of Water, 2011), which includes matters relating to the protection, restoration or rehabilitation of riparian corridors, so as to maintain or improve the stability and ecological functions of a watercourse.

Riparian corridors are comprised of the waterway, a Core Riparian Zone (CRZ) and a vegetated buffer. In accordance with the *Guidelines for Riparian Corridors* (NSW Office of Water, 2011), the CRZ for the un-named watercourse in the south of the site, measured from the banks of the stream, should be 10m. The recommended width for vegetated buffers is 10m. Hence, also incorporating the waterway itself, a conservative 30m buffer zone (riparian corridor) will be established from the on-site watercourse centreline. All water management measures, both temporary measures during the construction phase and permanent measures, will need to be located outside of this buffer (riparian corridor).

Under clause 38 of the *Water Management (General) Regulation 2011* public authorities, such as local councils, are exempt from section 91E(1) of the *Water Management Act 2000* in relation to all controlled activities that they carry out in, on or under waterfront land. This means that a Controlled Activity Approval is not required for the proposed works at the site, since the proponent is LMCC. However, in accordance with best practice and the "improve or maintain" principle, the proposed works should be undertaken in accordance with the guidelines for controlled activities wherever possible. These guidelines include *Controlled Activities: Guidelines for Riparian Corridors* (NSW Office of Water, 2011) as discussed above, *Controlled Activities: Guidelines for Vegetation Management Plans* (NSW Office of Water, 2010a) and *Controlled Activities: Guidelines for Outlet Structures* (NSW Office of Water, 2010b).

It has been recommended that a Vegetation Management Plan (VMP) be prepared as part of the mitigation measures for environmental impacts on flora and fauna at the site. This VMP should be prepared in accordance with *Controlled Activities: Guidelines for Vegetation Management Plans* (NSW Office of Water, 2010a). Vegetation and biodiversity aspects of this project are discussed in further detail in **Section 6.5** of this Environmental Assessment.

There are no outlet structures proposed to be constructed in any waterways on site. However, the principles outlined in *Controlled Activities: Guidelines for Outlet Structures* (NSW Office of Water, 2010b) should still be considered when designing the spillways for the sediment basins, as events greater than the 10 Year ARI may result in discharge of water from these sediment basins (permitted under the existing EPL).

It is considered unlikely that groundwater will be encountered during the excavation of the proposed landfill emplacement areas, with the exception of in the vicinity of the existing sediment basin in the north of the site. Along the pipeline route the likelihood of encountering groundwater is higher, given the increasing proximity to low-lying areas near Lake Macquarie. Excavations during periods of intense rainfall should be limited to reduce the likelihood of encountering groundwater. Groundwater extraction for construction purposes or operation of the facility is not proposed as part of the project for any purpose.

If groundwater is encountered during trenching or excavation works this will need to be managed appropriately.

Surfacing groundwater should be pumped out of the excavation areas and disposed of appropriately in accordance with specifications in the *Stormwater Water Management Plan*. Minor groundwater inflow could be handled by a conventional sump and pump method.

No groundwater extraction or extraction of water within alluvial sediments is currently proposed as part of the works; however, if during the detailed design phase a requirement for extraction is identified, then a licence under the relevant water legislation as identified above would be sought and a Water Extraction Management Plan prepared.

6.3.4.2 Operational Phase

Groundwater extraction for operational or any other purposes is not proposed as part of the project. Further, as all landfill cells are to be lined as part of the proposed works, impacts on groundwater are not anticipated.

Although not anticipated due to the location of the proposed works on site (away from known groundwater sources), should the need for dewatering be identified as part of the proposed excavation works, a *Dewatering Management Plan* would be prepared as part of the LEMP. If dewatering activities are required, a licence under the relevant water legislation (*Water Management Act 2000* for surface waters and water within alluvial sediments at the site or the *Water Act 1912* for groundwater in the bedrock at the site) would be sought prior to any dewatering activities being undertaken.

Additional groundwater monitoring wells will also be constructed at the AWMF site to allow groundwater to continue to be monitored into the future. Proposed future groundwater monitoring will follow similar procedures as the existing program, and would be undertaken in accordance with the conditions set out in the updated EPL to be issued by the EPA. Reporting (including the provision of Annual Returns to OEH) would also be undertaken in accordance with the EPL.

According to the Annual Returns from 2008 to 2010 there have been no instances of non-compliance regarding concentrations of contaminants at the AWMF site. If the groundwater monitoring results detect a possible groundwater pollution incident the following procedures will be put in place, as described in the existing LEMP (LMCC, 2006):

- Verification – If groundwater sampling indicates a breach of the agreed limits, the affected sampling location and indicator parameters will be re-sampled and analysed as soon as possible to verify the anomaly;
- Notification – If re-sampling indicates that there is still a breach, the EPA will be notified as soon as practicable by telephone and in writing within 14 days of the verification of the breach;
- Assessment – A *Groundwater Assessment Plan* will be prepared within 28 days of notification to assess the extent of groundwater pollution. The Plan will identify the specific contaminant/s and the nature and extent of pollution. The Plan will also detail a monitoring program listing analytes and location of sample points; and

- Remediation – If the *Groundwater Assessment Plan* confirms pollution of groundwater, a *Groundwater Contamination Remediation Plan* will be prepared and implemented.

Stormwater quality and quantity in the operational phase will be managed using the proposed sediment basins at the AWMF site. Based on the water quality and quantity modelling undertaken it is concluded that the proposed sediment basins are sufficient to reduce the average annual export of stormwater pollutants to acceptable levels and to retard peak flows to levels lower than under pre-development conditions. In addition the qualitative flood impact assessment found that downstream flood levels would remain lower than would be estimated under pre-development conditions.

The following recommendations are made in support of the proposed expansion:

- Proposed basins should be lined to prevent interaction with groundwater;
- The active storage depth in the proposed basins should be 0.75m from permanent water level to the level of the primary spillway;
- Overflows from the basins should be conveyed to the outfall(s) via 0.5m deep rock lined channel with base widths of 2m and side slopes of 1(V):2(H);
- Clean surface waters diverted around the landfill area should be directed towards the on-site un-named watercourse via a level spreader(s) and should consider the principles of the guideline *Controlled Activities: Guidelines for Outlet Structures* (NSW Office of Water, 2010b); and
- Stormwater quality monitoring should continue in accordance with the existing Annual Returns to ensure compliance with the EPL, which includes monitoring of four stormwater sites (Sites 6, 7, 8 and 9 in **Figure 6.7**). These sites are monitored in accordance with the conditions set out in M2 of the existing EPL, which includes the measurement of the same parameters as listed for groundwater in **Section 6.3.2.1**. New monitoring requirements are likely to be provided as part of any new EPL for the site, however monitoring frequencies or parameters would be unlikely to change.

The stormwater quality leaving the site is to be in accordance with the limits outlined by ANZECC (2000). Furthermore the existing EPL in place for the AWMF site identifies the following limits for stormwater discharges:

- A TSS discharge limit of 50 mg/L. Higher discharge concentrations are allowed at Sites 6 and 7 if the rainfall is higher than 90th percentile of the 5 day rainfall. Monitoring Sites 6 and 7 are located within the proposed new leachate pond and the existing sediment basin in the south of the site, respectively, (as shown on **Figure 5.5**). It is anticipated that this condition will be modified and new stormwater quality monitoring points will be specified); and
- All surface waters must be managed in drains that convey up to the 10 year ARI runoff away from disturbed areas of landfill.

It should be also noted that Schedule 5 of the PoEO (General) Regulation 2009 defines water pollution and under this Schedule the ANZECC (2000) guidelines are identified as the appropriate standard against which chemical toxicants should be compared.

The three basins proposed to capture stormwater runoff from the landfill during its operation should also be maintained following capping for on-going stormwater management.

To avoid the generation of excessive leachate, erosion of cover material and/or waste from the landfill, stormwater controls should prevent any stormwater from mixing with waste, and prevent any sediment or contaminants from being carried off the landfill site. Stormwater controls should generally conform with the following principles (EPA, 1996):

- All water that has entered waste-filled areas, and water that has been contaminated by leachate, should be handled and treated in the same manner as leachate;
- All stormwater that has been collected from cleared or non-vegetated surfaces should be treated in accordance with *Managing Urban Stormwater: Harvesting and Reuse* (DEC (2006d); and
- The exposed or cleared areas at the landfill site should be minimised at all times, and all topsoil set aside for revegetation purposes. All completed areas of the landfill should be progressively revegetated, and any areas exposed for greater than 30 days should be stabilised so as to prevent soil erosion.

According to the Annual Returns from 2008 to 2010 there have been no instances of non-compliance regarding concentrations of water contaminants at the AWMF site. If stormwater pollution is detected, the following remediation procedures should be implemented, as described in the existing LEMP (LMCC, 2006):

- Take immediate action to contain any known breach as best as possible;
- Implement the procedures set out in the *Water Contamination Remediation Plan* as described in the existing LEMP; and
- Prepare a report to the EPA in accordance with specifications in the EPL and the document *Environmental Guidelines: Solid Waste Landfills* (EPA, 1996). The report would detail the nature and source of contamination, any actions taken, and future actions that will be carried out to prevent recurrence.

6.4 Leachate

A leachate generation model was used to estimate the quantities of leachate that will be generated by the landfill operations and the quantities that need to be removed from site for treatment and disposal. Model results indicate that the maximum quantity of leachate generated at the site (averaged over the period 2012 - 2033) is 6336 kL/month, whilst the maximum amount needed to be removed for treatment and disposal (averaged over the period 2012 - 2033) is 3875 kL/month.

6.4.1 Introduction

Leachate is generated by rainfall runoff passing through the waste in a landfill. This leachate needs to be managed to avoid its release into the natural environment. The generation of leachate is normally at its maximum during active landfilling processes due to the lack of waste to absorb the stormwater that falls on the landfill cell. If not well managed, the period of active landfilling can place capacity stress on the leachate collection and treatment system. Staging of the landfilling operations is important to minimise the area of uncapped landfill from which rainfall runoff will be contaminated and become leachate.

LMCC has undertaken preliminary consultation with Hunter Water Corporation (HWC) in order to determine HWC's requirements, issues and recommendations for off-site leachate disposal to the HWC sewer network. The outcomes of and recommendations from this consultation are discussed in this section.

6.4.2 Existing Environment

The AWMF currently has an operational leachate management system. Leachate at the site is managed using two existing leachate storage dams, one to the north of the current landfill area with 8ML capacity and one to the south with 6ML capacity. The site is currently unsewered and no excess leachate is disposed of off-site under existing operations. The exception to this is during an incident, such as in June 2007, when approximately 60kL of leachate needed to be removed from the AWMF site using tankering services (a semi-trailer). The leachate was disposed of at Dora Creek Waste Water Treatment Works (WWTW) during this incident (GHD, 2011).

Under the current leachate management system leachate spraying is the only form of regular leachate disposal, in accordance with License No. 5873. Leachate spraying is carried out at the site during appropriate weather conditions, such as dry weather (no rain) with appropriate wind directions. Leachate spraying is monitored to ensure that no leachate runoff occurs off site.

The lateral expansion of the AWMF is proposed to occur in two areas – Area A to the north east of the current landfilled area, and Area B to the north-west. Both of these areas grade down to the south in line with the general contours of the site. Additional waste will also be placed in Area C, over the existing landfill.

A leachate generation model has been developed (discussed in **Section 6.4.3**) to assess the amount of leachate generated by the expanded landfill. This model has been used to assess the implications of developing the new landfill cells in stages so as to minimise the amount of leachate generated, commensurate with ensuring each stage provides sufficient area for efficient landfilling operations and economical stages for installing lining and leachate collections systems, including the transferring of leachate offsite via the proposed sewer pipeline.

6.4.3 Potential Impacts

The addition of excavated Areas A and B to the landfill footprint and the continued deposition of waste in Area C (over the existing landfill) will allow for more waste to be deposited at the landfill (note that the existing landfill (located below the proposed emplacement Area C is currently unlined). For this to occur and for the leachate from this newly deposited waste to be contained, a "piggyback" liner will be required to be placed over the existing waste in Areas A, B and C. The detailed design of this liner will need to be based on the following design principles:

- Selection of an appropriate liner material, such as linear low density polypropylene;
- Differential settlement;
- Management of landfill gas produced by the underlying waste;
- Slope stability and slope length; and
- Stormwater management and the construction and landfill methodology.

6.4.3.1 Leachate Generation Model

A leachate generation model has been developed in accordance with the requirements stated in the Director General's Requirements. The model is based on a Water Balance analysis using monthly time steps over the life of the landfill. The timeframe extends for one year after the closure and capping of the final landfill cell, calculated to be December 2032, based on the available volume within the expanded landfill design. The model assumes a 1.3% annual increase in the tonnages of waste to be deposited at the landfill, as assumed in the Preliminary Environmental Assessment (LMCC, 2010). The assumed waste inputs to landfill are shown in the leachate model in **Appendix H**. The model timeframe starts in January 2012, assuming this is current day. The model is based on survey data for the existing landfill area as per the GHD concept design, which is based on average filling rates recorded at the AWMF between July 2006 and June 2009, in order to determine how much of the existing landfill site is still available for filling at this point in time.

Model Assumptions

The following assumptions and data have been used in the model.

- Rainfall and evaporation data from the nearest BoM station in Toronto (No. 61322), located approximately 4km from the AWMF site, has been used.

Average monthly rainfall data, 90th percentile wettest monthly rainfall data, and average monthly evaporation data from this station has been used;

- The percentage of rainfall that becomes leachate has been assumed as follows:
  - 50% for daily and intermediate cover areas;
  - 90% for daily and intermediate cover areas where the filling is in a cell below the surrounding natural ground level. This occurs in Cells A1 and A2. In the other cells the natural contours of the site allow for stormwater to be drained from the cell, and so a factor of 50% has been used in these cells;
  - 10% for final capping areas;
- The evaporation rate from dams is assumed to be 70% of the average monthly evaporation rate;
- The existing leachate dam to the north of the current landfill will be decommissioned and replaced with a 6-8ML storage dam (2,000m^2 area) to be used for leachate from Areas A and B (proposed location of the new leachate storage dam shown on **Figure 1.2** in the south-west of the AWMF site). For calculation purposes a storage dam capacity of 6ML is assumed to be conservative;
- The existing leachate storage dam (6ML capacity and 2,000m^2 in surface area) to the south of the current landfill area will be used for leachate from the current landfill and Area C. During the filling of Area C, the two leachate dams will be interconnected to maximise the use of the available onsite storage capacity;
- The absorptive capacity of the waste was assumed to be 0.03kL/tonne;
- The average monthly tonnages of waste received at the facility were estimated based on current tonnages and future population projections;
- There is no groundwater flow into the landfill cells;
- The leachate generated during the first year of operation of each cell has been calculated using the 90th percentile wettest monthly rainfall data;
- No leachate irrigation has been assumed; and
- The leachate storage required on site has been calculated using the following formula:
  - Leachate Storage = Leachate generated from rainfall infiltrating into the waste + groundwater inflow – the absorptive capacity of the waste – evaporation from the leachate storage dams – leachate removed from the site.

Model Results

The leachate generation model has been used to estimate the quantities of leachate that will be generated by the landfill operations and the quantities that need to be removed from site for treatment and disposal. The results are as shown in Table 6.10.

Table 6.10: Quantities of Leachate

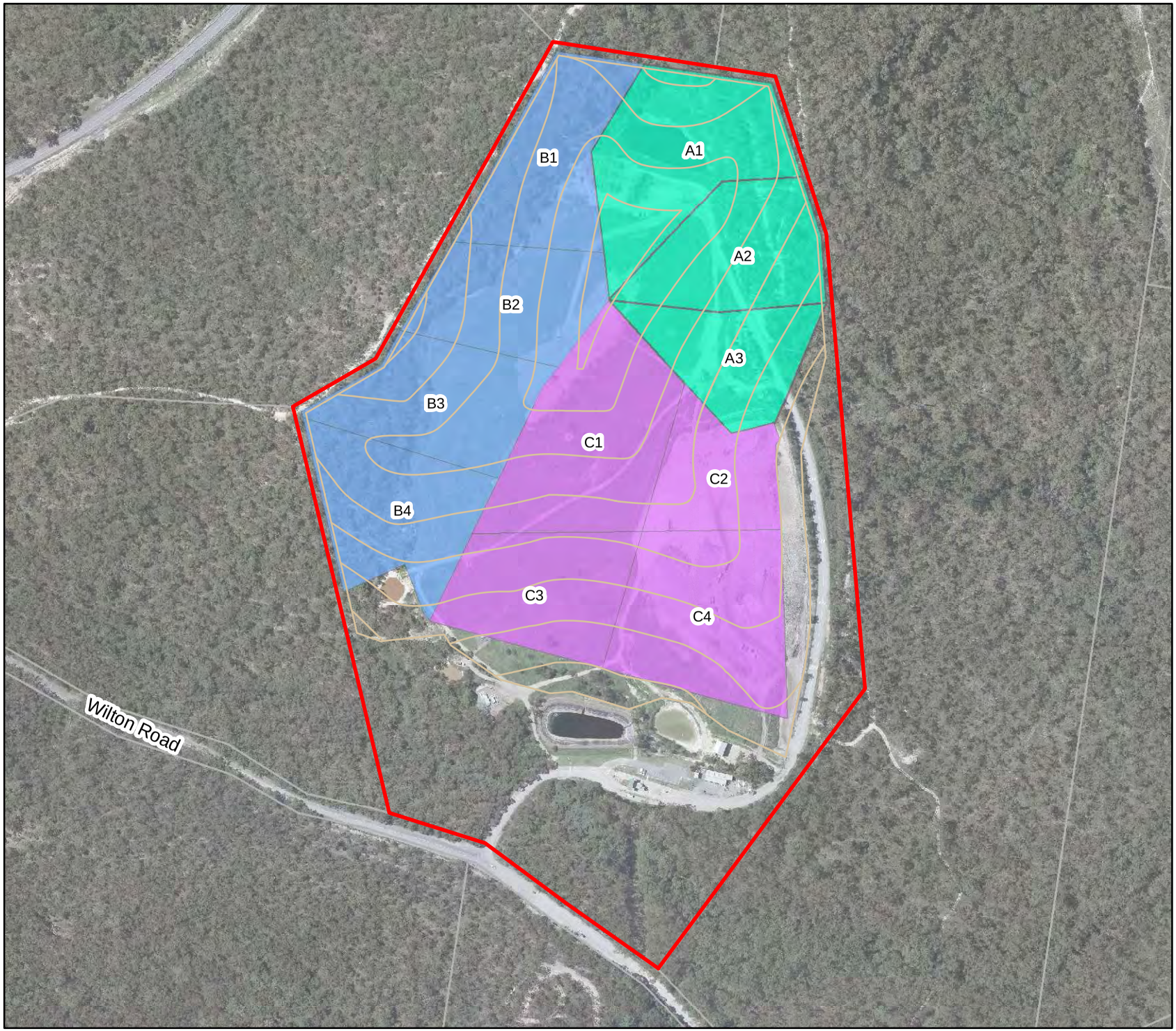
Period	Maximum Quantity of Leachate Generated per Month (kL)[1]	Maximum Quantity of Leachate Removed from Site per Month (kL)
January 2012 – December 2025	6,347	4,000
January 2026 – December 2030	7,141	4,500
January 2031 – July 2032	8,765	5,000
August 2032 – December 2033[2]	3,089	2,000

[1] Does not account for evaporation from the leachate dams

[2] One year after the closure of the final cell (Cell C4) in December 2032

6.4.3.2 Staging of Landfill Areas A, B and C

As a consequence of investigations into the amount of leachate generated by the expanded landfill operations using the leachate model, it is proposed that the expansion of the AWMF landfill be undertaken in 11 stages up until December 2032. An outline of the filling stages is shown in **Figure 6.9**. Each of the landfill cell Areas A, B and C is discussed below.



Lake Macquarie City Council

Staging of Landfill Areas A, B and C

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- Site Boundary
- Design Contours
- Stage A
- Stage B
- Stage C
- Cadastre

N
W E
S

FIGURE 6.9

1:5,000 Scale at A4

Metres

0 25 50 100 150 200

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6009_WorksStaging.mxd 02
Imagery supplied by LMCC and associated third party suppliers

Area A

It is proposed that Area A will be initially excavated and the northern area (approximately one third of the excavated area) will be lined with the base and side wall liners (including areas of existing landfill batters over which a "piggyback" liner will be constructed, as described for Area C) and the leachate collection system for this area installed. A temporary connection will be made from the leachate collection system of this cell (Cell A1) to the leachate collection sump in the southern end of Area A.

Cell A1 shall be filled to the final levels and then capped with a final capping. The area that can be capped will be less than the total area of the cell due to the batters of the waste where the cell adjoins Cells A2 and B1. Careful attention will need to be given to the design of the stormwater collection system to ensure that the amount of rainfall runoff that enters the active landfill cell is minimised.

The filling of Area A shall then continue with the subsequent development of cells A2 and A3 continuing from the north and moving south. At the completion of Cell A3, Area A will have been filled and capped, and the leachate collection system fully installed, except for the batters along the boundaries with the adjoining Areas B and C.

Table 6.11 provides details of the footprint areas and volume details of the three cells in Area A and the quantities associated with each of the stages.

Table 6.11: Area A Landfill Cell Details

Landfill Cell	Total Footprint Area (m^2)	Total Waste Quantity (Tonnes)	Area to be Capped in Stage (m^2)	Net Waste Capacity for Stage (Tonnes)	Estimated Stage Completion
A1	23,585	418,547	11,685	286,160	August 2014
A2	17,860	269,206	16,810	257,525	December 2016
A3	13,912	132,662	14,262	136,555	February 2018

Area B

Landfill Area B shall be developed and filled in a similar manner to Area A, commencing at the northern end (Cell B1) and developing cells moving south. It is proposed that Area B is developed in four stages (Cells B1 to B4). A separate leachate collection sump is proposed in the low point of Cell B4 to receive the leachate from Area B. Temporary connections will be made between the installed leachate collection system and the sump as each stage of the collection system is installed. Leachate will be drained from this sump to the leachate disposal system.

The active cell shall be capped with a final capping at the completion of each stage. Careful attention will need to be given to the design of the stormwater collection system to ensure that the amount of rainfall runoff that enters the active landfill cell is minimised.

The filling of Area B shall then continue with the subsequent development of cells B2, B3 and B4 continuing from the north and moving south. At the completion of Cell B4, Area B will have been filled and capped, and the leachate collection system fully installed, except for the batters along the boundaries with the adjoining Area C.

Table 6.12 provides details of the footprint areas and volume details of the four cells in Area B and the quantities associated with each of the stages.

Table 6.12: Area B Landfill Cell Details

Landfill Cell	Total Footprint Area (m^2)	Total Waste Quantity (Tonnes)	Area to be Capped in Stage (m^2)	Net Waste Capacity for Stage (Tonnes)	Estimated Stage Completion
B1	17,269	248,790	15,694	231,268	February 2020
B2	17,269	248,790	17,794	254,630	April 2022
B3	18,573	250,775	12,098	178,741	October 2023
B4	18,573	250,775	20,848	276,085	December 2025

Area C

Area C is to be mostly built over existing unlined landfilled areas. To ensure that leachate from the new waste deposited does not contaminate the environment, a leachate collection system will need to be built over the existing landfilled areas. For this to occur, the existing landfill cells will need to be capped with a bridging or foundation layer and impervious liner that is capable of ensuring that the liner and leachate collection system remains free flowing.

Prior to the foundation layer being installed, an intermediate capping and correction layer shall be installed to establish the grades required for the leachate collection system (a minimum of 10% over existing landfill, minimum of 3% in other areas). The thickness of this layer will vary depending on what is needed to achieve the required grades. The existing grades in the areas over which “piggyback” landfill cells will be constructed generally exceed 10%.

The foundation layer will comprise a compacted layer of clay placed over the correction layer. The depth of the clay layer will be 300 - 500mm. The foundation layer will be constructed of consecutive compacted clay layers with a permeability equivalent to $1x10^{-6}$m/s. The purpose of this layer is to provide a smooth even bearing surface for the support of the liner membrane and the leachate collection system for the new lined cells. It will also bridge any differential settlement of the existing waste below the liner.

It is proposed that a linear low density polyethylene (LLDPE) liner will be used.

Like the other areas, Area C will be developed commencing at the northern end (Cell C1) and progressively move south, down the natural slope of the site. A leachate collection system will be progressively constructed on the foundation layer within each stage of the filling of Area C.

A leachate sump will be constructed in the southern section of Cell C4. Temporary connections will be made between the installed leachate collection system and the sump as each stage of the collection system is installed. Leachate will be drained from this sump to the leachate disposal system.

The active cell shall be capped with a final capping at the completion of each stage. Careful attention will need to be given to the design of the stormwater collection system to ensure that the amount of rainfall runoff that enters the active landfill cell is minimised.

The filling of Area C shall then continue with the subsequent development of cells C2, C3 and C4 continuing from the north and moving south. At the completion of Cell C4, the expanded landfill will have been filled and capped, and the leachate collection system fully installed.

Table 6.13 provides details of the footprint areas and volume details of the four cells in Area C and the quantities associated with each of the stages.

Table 6.13: Area C Landfill Cell Details

Landfill Cell	Total Footprint Area (m^2)	Total Waste Quantity (Tonnes)	Area to be Capped in Stage (m^2)	Net Waste Capacity for Stage (Tonnes)	Estimated Stage Completion
C1	25,928	430,440	26,453	436,280	May 2029
C2	12,194	116,799	15,344	151,843	July 2030
C3	18,072	93,343	21,747	134,228	July 2031
C4	24,084	75,263	34,584	192,075	December 2032

6.4.4 Mitigation Measures

Independent leachate collection systems will be provided for Areas A, B and C. The leachate will be collected by gravity systems feeding into a leachate sump within each of the three areas. Leachate will then be pumped from the leachate collection sumps into leachate ponds. The existing 6ML leachate pond located south of Area C will be retained and a new leachate pond of approximately 8ML capacity will be constructed in the south-west of the site as shown on **Figure 1.2**.

In order to minimise and manage leachate generation, each of the new cell areas should be progressively excavated, then lined and the leachate collection system installed in preparation for receiving waste, in accordance with the staging plan outlined in **Section 6.4.3.2**.

6.4.4.1 Surplus Leachate Management – Off-Site Disposal

It was determined by the leachate investigations that excess leachate will be generated by the proposed expansion to the AWMF that will require disposal off-site. Four leachate disposal options have been assessed as part of the proposed works, in consultation with LMCC and HWC.

The option recommended for implementation is the proposed sewer pipeline route to be located in the road reserves along Wilton, Wangi and Dorrington Roads connecting to HWC's Rathmines No. 6 WWPS. This option results in leachate ultimately discharging into the Toronto WWTW. If practical and appropriate spray irrigation, which is currently practiced at the site, may continue.

Surplus leachate that is to be removed from site will be pumped to the Rathmines No. 6 WWPS operated by HWC, which is located approximately 2.5km directly southeast of the site. The rising main will be approximately 3.4km in length. Leachate will be drained from the leachate sumps within the landfill cells to the leachate dams. Leachate from these dams will be pumped to the proposed on-site AWMF package pumping station, which will have a duty and a standby pump. The package pumping station will be located adjacent to the existing leachate pond in the south, near the main entrance to the AWMF. This package pumping station will be connected to the F3590 maintenance hole at the Rathmines No. 6 WWPS via the rising main (sewer pipeline).

Based on the maximum volumes of leachate that will require off-site disposal over the design life of the landfill (5,000kL/month) and estimated maximum pump rates (11.6L/s based on approximately 4 hours of pump operation a day), a DN140 rising main is proposed for the sewer pipeline diameter. Polyethylene is proposed as the sewer pipeline material due to its resistance to corrosion in ASS (expected to be encountered along the route, particularly near the Rathmines No. 6 WWPS) and also its resistance to internal degradation from the leachate (GHD, 2011).

Some of the potential issues with the sewer pipeline that will need to be managed appropriately include slime growth, odour and septicity issues (due to extended detention times) and venting of gases generated from the leachate. In consultation with HWC these issues are proposed to be managed as follows (GHD, 2011):

- *Slime growth:* An annual maintenance activity is recommended to either chemically clean the pipeline or pig the pipeline. Monitoring of pump operations will also determine when a decrease in pump performance is occurring and cleaning or an annual maintenance chlorine dose may be required;
- *Odour and septicity issues:* The detention time of leachate in the DN140 rising main will sometimes be greater than the allowed four hours which may result in septicity issues. Chemical dosing of the leachate with iron salts is considered to be the most reliable form of septicity and odour control and has been recommended by GHD (2011) to manage these issues in the operational phase, also further consideration of use of iron salts will be required at the detailed design stage; and
- *Venting of gases:* HWC requires that the maintenance hole into which a rising main discharges has a vent stack to eliminate gases generated during transportation. Rathmines No. 6 WWPS has an existing vent stack and it is considered that gases generated from the leachate could be released via this vent stack.

Therefore no additional vent stack at F3590 (the receiving maintenance hole located in the access road to the WWPS) is required.

Having capacity in the leachate ponds on site and being able to manage leachate levels between the interconnected ponds in the event of an emergency (i.e. system failure) should prevent the need to discharge volumes to the Rathmines No. 6 WWPS that exceed the capacity of the WWPS system. In the event that excess leachate must be removed from site but cannot be pumped to the Rathmines No. 6 WWPS, leachate would need to be removed from the site using trucks or tankering services.

In the event of electrical or other failure of the Rathmines No. 6 WWPS, leachate flows from the package pumping station on the AWMF site will need to be stopped. As this package pumping station will be privately operated by LMCC it will not be controlled by the HWC system and therefore will not be automatically isolated in the event of a failure at the WWPS. To mitigate this potential risk a system involving structured communication between HWC operators and LMCC operators at the AWMF site should be implemented to alert the AWMF site to cease pumping leachate. Alternatively a spring-closed actuated valve could be used to stop flows from being delivered to the F3590 maintenance hole, possibly installed at the entry to F3590; however, this element requires further analysis during the detailed design phase (GHD, 2011).

Leachate Quality Management

LMCC will seek to establish a Trade Wastewater Agreement with HWC for the discharge of leachate from the AWMF site to the HWC sewer system.

An analysis of average leachate quality results obtained from the AWMF over the past two years was made against Trade Waste Agreement (TWA) limits HWC has placed on LMCC for similar facilities owned and managed by LMCC in order to determine what on-site treatment of the leachate is required prior to discharge to the sewer network. The results of this analysis and assessment of several treatment systems determined that to ensure leachate quality leaving the AWMF site meets HWC requirements aeration should be incorporated into the leachate management system as follows (GHD, 2011):

- Install floating surface aerators within the proposed 8ML leachate dam to convert this dam to an aerated pond;
  - Aeration improves the ability of the pond to remove BOD;
  - Sufficient alkalinity must be dosed to the raw leachate to achieve nitrification of ammonia in the aerated pond;
- Retain the existing 6ML leachate dam, so that it is not aerated but instead follows the aerated 8ML (plumbed in series, not in parallel) and acts as an aerobic / facultative pond;
  - This will act as a maturation pond to settle the sludge that is stirred up during aeration, prior to discharge of the treated leachate from the pond, hence reducing TSS concentrations in the treated leachate; and

- The second pond will almost completely remove nitrogen from the system (TKN and ammonia).

Based on the estimated flow rates, the detention time in each pond should be eight to 10 days if the ponds are operated in series. Preliminary process calculations indicate that the treated leachate quality that may be attained from the aerated leachate system is of a relatively high quality, with all parameters other than phosphorus being discharged at a concentration that is low enough to avoid the levying of a high strength charge by HWC, as indicated in **Table 6.14** (GHD, 2011). The exception could be phosphorus; however, chemical dosing with alum or ferrous chloride for example would be likely to enable low resultant phosphorus limits to be achieved.

Table 6.14: Predicted Treated Leachate Quality and Likely HWC TWA Requirements (GHD, 2011)

Key HWC Leachate Quality Parameters	Estimated Untreated Leachate Concentrations (mg/L)	Predicated Treated Leachate Concentrations (mg/L)	Concentration Limit on TWA by HWC for Similar LMCC Facilities (mg/L)
Biochemical Oxygen Demand (BOD)	1,270	<20	<500
Non Filtratable Residue	155	<30	<500
Total Kjeldahl Nitrogen (TKN)	424	<40	<150
Ammonia	N/A	<10	N/A
Total Phosphorus (TP)	80	N/A	N/A

In accordance with HWC's requirements a sewer flowmeter and a sampling point will be located at the AWMF package pumping station such that volumes and quality of leachate discharged to the HWC sewer network can be monitored (GHD, 2011).

Sludge management is likely to be a significant operational issue for the aerated pond and contracted desludging works are likely to be required annually (GHD, 2011).

6.5 Flora and Fauna

Murray *et al* (2012) identified a total impact footprint area of 8.55ha on Lot 372 within which clearing is proposed as part of the AWMF works. Of this, Niche (2012a) identified 7.2ha of native vegetation types to be cleared that will require biodiversity offsetting (2.16ha of Smooth-barked Apple – Red Bloodwood open forest [HU621] and 5.04ha of Scribbly Gum – Red Bloodwood health woodland [HU610]). The proposed AWMF expansion works will also result in the loss of 2,302 plants of *Tetratheca juncea* (Black-eyed Susan).

The proposed sewer pipeline works will result in the removal of approximately 1ha of mostly modified groundcover vegetation within the proposed 3m wide construction easement, the majority of which is exotic herbaceous groundcover and not substantial vegetation. Less than 0.1ha of the total 1ha comprises moderate quality native vegetation.

Additional impacts as a result of the proposed expansion include inadvertent damage to or removal of vegetation to be retained, inadvertent spread of weeds and establishment of new weeds in disturbed areas and death or injury of wildlife. It was concluded that the pipeline route is likely to incur negligible impacts on species or habitats for threatened fauna since the pipeline route will be revegetated.

6.5.1 Introduction

Murray *et al*. (2012) conducted flora and fauna surveys over the AWMF site and the adjacent Lot 373. Three broad fauna habitat types were identified and a total of 189 plant taxa were recorded within the AWMF site and surrounds (Murray *et al*., 2012). This report is provided in **Appendix I**. Niche (2012b) conducted a flora and fauna assessment and survey along the proposed sewer pipeline route to the Rathmines No. 6 WWPS. This report is provided in **Appendix J**.

The following sections describe the existing flora and fauna at the site of the proposed expansion works at the AWMF site and along the sewer pipeline route, and provide an assessment based on the existing environment and proposed works.

A biodiversity offset report was also prepared by Niche (2012a) for the proposed works. This report is provided in **Appendix K**.

6.5.2 Existing Environment

Detailed flora and fauna investigations at the AWMF site and surrounds were undertaken in 2010/2011 (Murray *et al*., 2012). Subsequent flora and fauna investigations were undertaken by Niche (2012b) in October 2011 along the sewer pipeline. The findings are discussed below.

6.5.2.1 Flora – AWMF Site and Surrounds

Flora surveys at the AWMF site and surrounds were conducted during February 2011, while intensive surveys for threatened flora species were completed between September and December 2010. A total of 189 plant taxa were recorded within the AWMF site and the adjacent Lot 373.

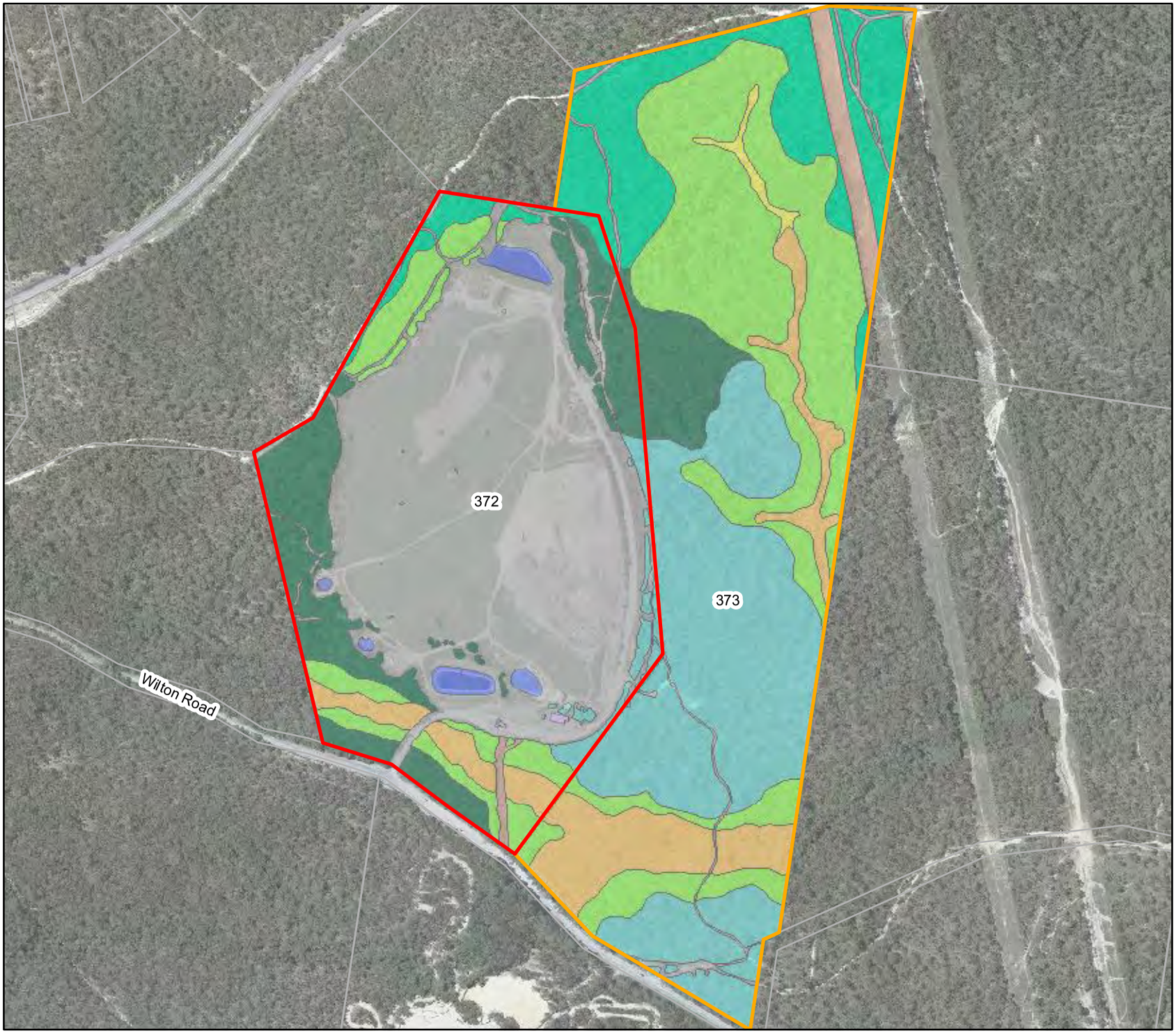
Native Vegetation Communities

Intensive flora surveys were conducted for the study area and surrounds. They record a total of 189 plant taxa within the AWMF site (Lot 372) and the adjacent Lot 373. Several native vegetation communities were observed on Lots 372 and 373, namely:

Several native vegetation communities were observed by Murray *et al.* (2012) on Lots 372 and 373, including:

- Sugarloaf Lowlands Bloodwood-apple Scribbly Gum Forest (5.28ha);
- Freemans Peppermint-apple Bloodwood Forest (2.73ha);
- Red Mahogany-paperbark Thicket (1.12ha);
- Coastal Plains Scribbly Gum Woodland (0.83ha); and
- Sugarloaf Lowlands Bloodwood-apple Forest (0.73ha).

These five native vegetation communities total an area of 10.69ha, and none are listed as EEC's in NSW under the TSC Act or nationally under the EPBC Act. The location of the vegetation communities on Lots 372 and 373 is shown in **Figure 6.10**.



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Location of Vegetation Communities

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- Site Boundary
- Lot 373
- Cadastre

Vegetation Communities

- Red Mahogany-Paperbark Thicket
- Peppermint-Black Wattle Riparian Forest
- Freemans Peppermint-Apple-Bloodwood Forest
- Bloodwood-Apple Forest
- Apple-Scribbly Gum Forest
- Coastal Plains Scribbly Gum Woodland
- Cleared
- Infrastructure
- Disturbed: Regrowth
- Dam

N
W E
S

FIGURE 6.10

1:7,000 Scale at A4

Metres
0 25 50 100 150 200

Cardno

Data Source: Murray et al. (2011)
Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-08-28
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6010_VegCommunities_v2.mxd 03
Imagery supplied by LMCC and associated third party suppliers

Threatened Flora – Desktop Assessment

Murray *et al*. (2012) conducted a 5km desktop search of the locality on the LMCC, OEH and DSEWPaC flora databases. Records were returned for the following five plant species:

- *Acacia bynoeana*;
- *Angophora inopina*;
- *Cryptostylis hunteriana*;
- *Grevillea parviflora* ssp. *parviflora*; and
- *Tetratheca juncea.*

A brief description of each species, its habitat and the current legal status under the EPBC Act and TSC Act is outlined in **Table 6.15**.

Table 6.15: Threatened Flora Records Within a 5km Radius of the AWMF Site (Murray *et al.*, 2012)

Scientific Name	Common Name	Legal Status*		Brief Description	Habitat
		EPBC Act	TSC Act		
Acacia bynoeana	Bynoe's Wattle	V	E	Small, cryptic and low-growing, spreading sub-shrub	In the immediate region, this species is generally found in Scribbly Gum woodland
Angophora inopina	Charmhaven Apple	V	V	Small to medium tree, often multi-stemmed, lignotuberous	In the immediate region, this species is found in Scribbly Gum or Brown Stringybark woodland/ forest
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	A leafless ground orchid that can only be found when flowering	Scribbly Gum, Red Bloodwood woodland/forest
Grevillea parviflora ssp. *parviflora*	Small-flower Grevillea	V	V	A small shrub from 30 cm to 2 m tall	Sandy or light clay soils in a variety of vegetation
Tetratheca juncea	Black-eyed Susan	V	V	A generally leafless, fine-stemmed clonal plant that can only be found when flowering	Mostly Scribbly Gum and Smooth-barked Apple communities

* V = Vulnerable and E = Endangered under the Acts

Threatened Flora – Field Survey

Systematic transect flora surveys were conducted by *Murray et al.* (2012) between September 2010 and December 2010 that targeted the above five threatened flora species. A GPS device was used to delineate the distribution of species and the results are presented graphically in **Figure 6.11**. Each GPS point can represent multiple counts of individuals and as such, GPS points only convey a general idea of the distribution of each species.

Figure 6.11 shows that *Grevillea parviflora* ssp. *parviflora* and *Tetratheca juncea* were recorded within the AWMF site (Lot 372). The other three species listed in **Table 6.15** were not recorded within Lot 372 or within an area which will be impacted by the pipeline route and hence are not considered further as they will not be impacted by the proposed works.

Lake Macquarie City Council

Location of Threatened Flora Species

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- Site Boundary
- Tetratheca juncea
- Grevillea parviflora ssp. parviflora
- Angophora inopina
- Acacia bynoeana
- Cadastre

N
W E
S

FIGURE 6.11

1:7,000 Scale at A4

Metres
0 25 50 100 150 200

Cardno

Data Source: Murray et al. (2011).
Map Produced by Cardno NSW/ACT Pty Ltd
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6011_ThreatenedFlora.mxd 02
Imagery supplied by LMCC and associated third party suppliers

Table 6.16 presents a summary of the number of threatened plant records on the AWMF site (Lot 372) as recorded during field surveys.

Table 6.16: Threatened Flora Counts on Lot 372 and within the proposed footprint (Murray *et al.*, 2012)

Threatened Species Name	Legal Status*		Number of Plants on Lot 372	Number of Plants in proposed footprint
	EPBC Act	TSC Act		
Tetratheca juncea (Black-eyed Susan)	V	V	2,333	2,302
Grevillea parviflora ssp. *parviflora* (Small-flower Grevillea)	V	V	280	0
TOTAL	-	-	2,613	2,302

* V = Vulnerable and E = Endangered under the Acts

Tetratheca juncea

Tetratheca juncea (Black-eyed Susan) is a low shrub that grows as a single stem or clumps of stems arising from a single rootstock, with an individual plant being able to grow into a clump of as many as 200-500 individuals. *Tetratheca juncea* has hanging pink flowers, usually with four petals, that are bisexual and odourless. *Tetratheca juncea* is endemic to NSW and the current distribution is divided into two metapopulations. The AWMF site is located within the central coast metapopulation (from Wyong to Beresfield).

Overall there was a high density of *Tetratheca juncea* in the surveyed area. Adjusting for the unsuitable habitat (i.e. cleared areas and riparian areas) there were 340 clumps per hectare. This compares with a regional mean density of just under 40 clumps per hectare (derived from 13 similar studies covering a total of 174ha (Driscoll, 2010, unpublished)). Within Lot 372, a total of 2,333 *Tetratheca juncea* plants were located. This survey result is likely to represent around 98% of the total numbers present (Murray *et al.*, 2012).

Grevillea parviflora ssp. parviflora

Grevillea parviflora ssp. *parviflora* (Small-flower Grevillea) is a low spreading to erect shrub mostly to 1.5m high. Leaves are crowded, erect to ascending, narrow, mostly 2-3.5cm long, and approximately 1.3mm wide with the lower surface silky hairy and the tip with a short point. Flowers are “spider-like”, small and white or pinkish (Lower Hunter populations) with rusty-brown hairs (NPWS, 2002).

Grevillea parviflora ssp. parviflora occurs on sandy clay loam soils, often with lateritic ironstone gravels. Soils are mostly derived from tertiary sands or alluvium and from the Mittagong formation with alternating bands of shale and fine-grained sandstones. *Grevillea parviflora* ssp. *parviflora* is recorded in a variety of plant communities and there are substantial populations within the Werakata National Park in the lower Hunter Valley region (NPWS, 2002).

The following describes the plants recorded in the AWMF site and surrounding survey area:

- Majority of the surveyed plants – generally taller shrubs (up to 2m), small white flowers and typical leaves;
- A patch of plants – white flowers but with distinctly broader leaves; and
- A small patch of plants – typical leaves but with pink flowers.

There are scattered records for the species from throughout the immediate region in which the AWMF survey was situated. Within Lot 372, a total of 280 Small-flower Grevillea plants were located, all of which occur outside of the proposed disturbance area due to the expansion works at the AWMF site.

In addition to those threatened species recorded on the subject site following extensive surveys, and review of threatened species in the locality, the federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) requested one additional threatened flora species be assessed in this report – Biconvex Paperbark (*Melaleuca biconvexa*). No evidence of Biconvex Paperbark was recorded despite the entire site being intensively sampled by foot traverses for other threatened plant species, and as such, any impacts on this species are anticipated to be negligible.

6.5.2.2 Flora – Sewer Pipeline Route

Niche undertook a field survey of flora along the sewer pipeline route during their flora and fauna assessment. They reported that a considerable proportion of the groundcover within the direct footprint of the pipeline works contained road base, bare ground, post roadwork grass seeding (such as at the intersection of Wangi and Dorrington Roads) and various other exotic grass and forb species. Most of the groundcover vegetation within the pipeline footprint is regularly maintained (with the exception of steeper batters on the eastern corner of the intersection of Wangi and Dorrington Roads and creek and drainage crossings (Niche, 2012b).

As a result of previous road, drainage and other infrastructure works most of the pipeline footprint exhibits considerable soil disturbance and vegetation modification. The area immediately beyond the pipeline footprint is representative of moderate to high quality native bushland, the exception being the Toronto Golf Course and transecting electrical easements (Niche, 2012b).

Native Vegetation Communities

Niche (2012b) determined that the following native vegetation communities are located along the sewer pipeline route (see **Appendix J** for details of locations), with those that will be affected by the proposed works marked with an asterisk:

- Swamp Oak-Rushland Forest (EEC);
- Swamp Oak–Sedge Forest (EEC);
- *Red Mahogany-Paperbark Thicket;

- *Foreshore Redgum-Rough-barked Apple Forest;
- Narrabeen Alluvial Sedge Woodland;
- *Coastal Plains Smooth-barked Apple Woodland;
- *Coastal Plains Scribbly Gum Woodland;
- *Freemans Peppermint-apple Bloodwood Forest; and
- *Sugarloaf Lowlands Bloodwood-Apple Scribbly Gum Forest.

The six vegetation communities above marked with an asterisk will have minor components of their communities removed by the proposed works, however, the loss would be small, totalling less than 0.1ha. The remaining vegetation to be removed (approximately 0.98ha) comprises exotic vegetation which is generally moderately to highly modified herbaceous roadside groundcover. Notably, neither of the two EECs listed above (Swamp Oak-Rushland Forest, and Swamp Oak-Sedge Forest), which are located in the immediate vicinity of the works along the access road to the Rathmines No. 6 WWPS, will be affected by the works (Niche, 2012b).

Vegetation communities along the sewer pipeline route are shown in Figure 3 of the flora and fauna report in **Appendix J** (Niche, 2012b).

Threatened Flora – Desktop Assessment and Field Survey

Three threatened plant species (*Tetratheca juncea*, *Grevillea parviflora* ssp. *parviflora* and *Angophora inopina*) were recorded by Niche during the field survey in close proximity to the pipeline footprint (see **Table 6.17**). However, none will be directly affected by the proposed pipeline. By confining the pipeline footprint to a 3m wide easement within mostly modified roadside vegetation, the threat to local threatened species and EECs is considered low (Niche, 2012b). The location of these threatened flora species along the sewer pipeline route is shown in Figure 8 of the flora and fauna report in **Appendix J** (Niche, 2012b).

Based on previous records found during the flora database searches, two additional species were also considered to have a low or moderate likelihood of occurring within the study area. These are also listed in **Table 6.17**.

Table 6.17: Threatened Flora Known or Potentially Occurring Along the Pipeline Route (Niche, 2012b)

Scientific Name	Common Name	Legal Status*		Likelihood of Occurrence	Potential Impact on Species or Habitat
		EPBC Act	TSC Act		
Acacia bynoeana	Bynoe's Wattle	V	E	Moderate	Negligible
Angophora inopina	Charmhaven Apple	V	V	Known	Negligible
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Low-moderate	Negligible
Grevillea parviflora ssp. *parviflora*	Small-flower Grevillea	V	V	Known	Negligible

Scientific Name	Common Name	Legal Status*		Likelihood of Occurrence	Potential Impact on Species or Habitat
		EPBC Act	TSC Act		
Tetratheca juncea	Black-eyed Susan	V	V	Known	Negligible

* V = Vulnerable and E = Endangered under the Acts

6.5.2.3 Fauna – AWMF Site and Surrounds

Murray *et al.* (2012) conducted fauna surveys at the AWMF site and surrounds between November 2010 and February 2011. The fauna surveys consisted of a number of components including:

- A habitat tree survey;
- Diurnal and nocturnal surveys for birds;
- Elliott, cage and tree trapping for mammals;
- Spotlighting for mammals;
- Harp traps and Anabat recordings for bats; and
- Diurnal and spotlight searches for mammals and amphibians.

Threatened Fauna – Desktop Assessment

Murray *et al*. (2012) conducted a 5km desktop search of the locality on the LMCC, OEH and DSEWPaC fauna databases. Records were returned for the following 31 fauna species:

- **Birds:**
  - Black Bittern;
  - Eastern Osprey;
  - Australian Pied Oystercatcher;
  - Black-winged Stilt;
  - Glossy Black Cockatoo;
  - Gang-gang Cockatoo;
  - Little Lorikeet;
  - Swift Parrot;
  - Turquoise Parrot;
  - Powerful Owl;
  - Sooty Owl;
  - Masked Owl;
  - Regent Honeyeater;
  - Scarlet Robin; and
  - Varied Sittella.

- **Mammals:**
  - Spotted-tail Quoll;
  - Koala;
  - Squirrel Glider;
  - Grey-headed Flying-fox;
  - East-coast Freetail Bat;
  - Little Bent-wing Bat;
  - Eastern Bent-wing Bat;
  - Large-eared Pied Bat;
  - Eastern False Pipistrelle;
  - Southern Myotis;
  - Greater Broad-nosed Bat; and
  - Eastern Cave Bat.
- **Amphibians:**
  - Stephens Banded Snake;
  - Green and Golden Bell Frog;
  - Heath Frog (*Litoria littlejohni*); and
  - Wallum Froglet.

Threatened and Migratory Fauna Surveyed

One threatened mammal species was recorded on Lot 372, the East-coast Freetail Bat. This species was recorded on the north-eastern boundary of the landfill site by interpretation of echolocation calls. Additional threatened mammal species recorded in the adjacent bushland (Lot 373) include Squirrel Glider, Little Bent-wing Bat and Eastern Bent-wing Bat. These additional species are considered highly likely to utilise habitats on the AWMF site (Lot 372). Additionally, the East-coast Freetail Bat and Squirrel Glider may utilise tree hollows occurring on the landfill site for roost and den sites (Murray *et al.*, 2012).

No threatened bird species were recorded within Lot 372 during the surveys. However, the vulnerable Varied Sittella was recorded in the adjacent bushland (Lot 373) and would likely utilise the AWMF site as part of its larger foraging range. Three birds listed as Migratory under the EPBC Act were recorded within the AWMF site, including the Australian Wood Duck, Whistling Kite and White-throated Needletail. A fourth species, the White-bellied Sea Eagle was observed nesting on the adjoining Lot 373 and was observed flying in proximity to the AWMF site (Murray *et al.*, 2012).

No threatened fauna species listed under the EPBC Act were recorded in the AWMF site during the investigation, but one threatened fauna species was identified by Murray *et al.* (2012) as likely to occur; the Grey-headed Flying-fox.

Tables 6.18 and **6.19** summarise the results of the fauna surveys undertaken by Murray *et al.* (2012) with respect to threatened and migratory fauna sightings on Lots 372 and 373.

In addition to those threatened species recorded on the subject site following extensive surveys and review of threatened species in the locality, DSEWPaC requested additional threatened species be assessed in this report as part of the project adequacy review. As such, Murray *et al* (2012) assessed the Green and Golden Bell Frog, Littlejohn's Tree Frog, Giant Barred Frog, Large-eared Pied-bat, Brushtailed Rock-wallaby, Long-nosed Potoroo and New Holland Mouse. Using the OEH Fauna Atlas (2012) and LMCC Fauna Database (2000), there are no recent records within a 20km radius of the Awaba site for any of these additional threatened species, with the exception of the Large-eared Pied Bat. In addition, no habitat exists to suggest the likely occurrence of several of these species, namely the Green and Golden Bell Frog, Littlejohn's Tree Frog, Giant Barred Frog, Brush-tailed Rock-wallaby, Long-nosed Potoroo and New Holland Mouse. Given these initial findings, the above species (with the exception of the Large-eared Pied Bat) were not considered likely to be present, and as such no further assessment has been made for these species. The Large-eared Pied Bat has been considered in more detail in the assessment by Murray *et al* (2012). Most records of this species are associated with gorge or rock outcrop landscapes with caves, as these landscape features are utilised by the species as roost sites. Murray *et al* (2012) determined that potential foraging habitat is present at the subject site for the Large-eared Pied Bat, however suitable rocky outcrops or other roost habitat is not present, so potential occurrence of this species on Lot 372 is considered to be low.

Table 6.18: Threatened Fauna Species Records on Lots 372 and 373 (Murray *et al.*, 2012)

Common Name	Scientific Name	Legal Status*		Record Location
		EPBC Act	TSC Act	
East-coast Freetail Bat	*Mormopterus norfolkensis*	-	V	Lots 372 and 373
Eastern Bent-wing Bat	*Miniopterus schreibersii oceanensis*	-	V	Lot 373
Little Bent-wing Bat	*Miniopterus australis*	-	V	Lot 373
Squirrel Glider	*Petaurus norfolcensis*	-	V	Lot 373
Varied Sittella	*Daphoenositta chrysoptera*	-	V	Lot 373

* V = Vulnerable and E = Endangered under the Acts

Table 6.19: Migratory Bird Species Records on Lots 372 and 373 (Murray *et al.*, 2012)

Common Name	Scientific Name	Legal Status*			Record Location
		EPBC Act	TSC Act	Other	
Australian Wood Duck	*Chenonetta jubata*	M	-	-	Lot 372
Whistling Kite	*Haliastur sphenurus*	M	-	-	Lot 372 and overhead

Common Name	Scientific Name	Legal Status*			Record Location
White-throated Needletail	*Hirundapus caudacutus*	M	-	JAMBA	Lot 372 (overhead)
White-bellied Sea Eagle	*Haliaeetus leucogaster*	M	-	CAMBA	Lot 373 – nest located and overhead nearby

* M = Migratory under the EPBC Act; CAMBA = China-Australia Migratory Bird Agreement and JAMBA = Japan-Australia Migratory Bird Agreement (two bilateral agreements relating to the conservation of migratory birds)

Figure 6.12 shows the recorded locations of observed threatened fauna species at the AWMF site and surrounds.

Grey-headed Flying-Fox (Pteropus poliocephalus)

The Grey-headed Flying-fox is listed as vulnerable under the EPBC Act. Although this species was not recorded within the AWMF site or surrounds during surveys, it is considered highly likely to utilise the forested parts of the subject site as a component of its extensive foraging range.

The Grey-headed Flying-fox is Australia's largest bat, with a head and body length of 23 to 29cm. This species feeds on the nectar and pollen of native trees, in particular *Eucalyptus, Melaleuca* and *Banksia*, and fruits of rainforest trees and vines. Populations congregate in roosting camps, which are typically located within 20km of a regular food source. These camps are commonly found in gullies, close to water and in vegetation with a dense canopy. An individual camp may have tens of thousands of animals and are used for mating, birthing and the rearing of young. The species travels up to 50km during foraging.

This species is considered highly likely to utilise the forested parts of the AWMF site and surrounds as a component of its extensive foraging range, particularly during times of flowering of *Eucalyptus, Corymbia* and *Angophora* tree species. Ripe fruits of rainforest trees along the smaller creeklines (for a period of the year when this resource is available) may also provide an attractive foraging resource (Murray *et al*., 2012).

Lake Macquarie City Council

Location of Threatened Fauna Species

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- Site Boundary

Threatened Fauna

- Eastcoast Freetail-bat
- Eastern Bent-wing Bat
- Little Bent-wing Bat
- Squirrel Glider
- Varied Sitella

EPBC Migratory Fauna

- Australian Wood Duck
- Whistling Kite
- White-bellied Sea Eagle
- White-throated Needletail
- Cadastre

N
W E
S

FIGURE 6.12

1:7,000 Scale at A4

Metres
0 25 50 100 150 200

Cardno

Data Source: Murray et al. (2011)
Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6012_ThreatenedFauna.mxd 02

Fauna Habitat Surveyed

Murray *et al*. (2012) found that there are three broad fauna habitat types within the AWMF site:

- **Open Forest/Woodland:**
  - Open Forest is dominated by taller trees (to 20m in height) with a tall and low understorey vegetation layer. Tree species occurring in this habitat include Sydney Red Gum (*Angophora costata*), Sydney Peppermint (*Eucalyptus piperita*), Brown Stringybark (*Eucalyptus capitellata*) and Red Bloodwood (*Corymbia gummifera*). Taller understorey plant species (to 3m in height) include (*Banksia serrata*) and low understorey is dominated by *Banksia spinulosa*, *Banksia oblongifolia* and Mountain Devil (*Lambertia formosa*); and
  - Open Woodland includes tree species *Eucalyptus haemastoma* and *Eucalyptus piperita* and is characterised by a very open understorey. Taller understorey species are generally not present; however, the low understorey is dominated by *Banksia spinulosa*, *Xanthorrhoeae latifolia* ssp.*latifolia* and grasses.
- **Riparian Forest:** Occurs along the ephemeral creek lines and supports similar tree species composition to the Open Forest / Woodland. However, due to the more sheltered and moister environment, the trees are taller in height, reaching 22 to 25m. The understorey is taller (to 4m in height) and includes *Leptospermum polygalifolium*, Black Wattle (*Callicoma serratifolia*), Christmas Bush (*Ceratopetalum gummiferum*) and Gymea Lily (*Doryanthes excelsa*). Low understorey and ground layer vegetation include ferns and herbs.
- **Cleared Grassland:** No habitat trees occur within this habitat type. However, this habitat is likely to provide terrestrial foraging areas (e.g. in grassed areas), aquatic foraging areas (e.g. in man-made basins) and sheltering habitat (e.g. near man-made infrastructure) for a number of fauna species.

Non-threatened and Native Species Surveyed

Birds

Within the AWMF site, a total of 21 bird species were recorded by census surveys, with an additional 17 species recorded by opportunistic observations outside of the census period. Within the locality, a total of 206 bird species have been recorded, but this total includes a large number of bird species that would not occur at the AWMF site due to absence of suitable habitat. For example, the locality (<5km radius) includes aquatic and estuarine habitats associated with Lake Macquarie. Many bird species associated with habitats in Lake Macquarie would not occur on the AWMF site, or utilise the habitats as part of their regular movements (Murray *et al.*, 2012).

No threatened bird species was recorded within the AWMF site; however, the threatened Varied Sittella was observed foraging in the Open Forest / Woodland in adjoining bushland and would likely forage in the areas of remnant forest on the AWMF site.

The majority of bird species recorded are forest dependent; however, some aquatic bird species (such as the Australian Pelican, Silver Gull and Australian White Ibis) and one nocturnal species (Australian Owlet-nightjar) were recorded at the AWMF site. One additional nocturnal bird species was recorded in adjacent bushland and would forage on the landfill site as part of its foraging range (Tawny Frogmouth) (Murray *et al.*, 2012).

Mammals

Seven native mammal species were directly observed on the AWMF site, including:

- Three smaller terrestrial mammals – Brown Antechinus (*Antechinus stuartii*), Swamp Rat (*Rattus lutreolus*) and Northern Brown Bandicoot (*Isoodon macrourus*);
- One arboreal mammal – Common Brushtail Possum (*Trichosurus vulpecula*); and
- Three microchiropteran bats – White-striped Freetail-Bat (*Austronomus australis*), Gould's Wattled Bat (*Chalinolobus gouldii*) and Little Forest Bat (*Vespadelus vulturnus*).

During spotlight searches a further four species of aboreal possums were recorded on the adjoining Lot 373 – the Common Ringtail Possum, Common Brushtail Possum, Squirrel Glider and Feathertail Glider. All four species are considered likely to occur in the remnant forest and woodland on the AWMF site (Murray *et al.*, 2012).

Murray et al. (2012) recorded five bat species by echolocation calls on the AWMF site and a further two species were on the adjacent Lot 373. These species included the three bat threatened bat species listed in **Table 6.18**, the three microchiropteran bats listed above, as well as the Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) and Chocolate Wattled Bat (*Chalinolobus morio*) (see **Appendix I** for full details). In addition one Lesser Long-eared Bat (*Nyctophilus geoffroyi*) and one Little Forest Bat (*Vespadelus vulturnus*) were captured on the adjacent Lot 373 using harp traps.

Larger native terrestrial mammals were not recorded on the landfill site, but macropod scats were observed and indicate their presence. The Swamp Wallaby was observed along the riparian zone of the adjoining Lot 373 and would likely forage on the AWMF site. Two additional larger macropods have previously been recorded in the locality, including the Red-necked Wallaby and Eastern Grey Kangaroo. No evidence of the threatened Spotted-tail Quoll was observed, although the AWMF site contains several habitat trees with hollows, and also ground logs that may be suitable as den sites for the species (Murray *et al.*, 2012).

Murray *et al.* (2012) found that there have been no sightings of Koalas in the Awaba locality since 1972 (at Kilaben Bay). Results of investigations by Murray *et al.* (2012), including habitat assessments and spotlight/scat searches of the area suggest that no 'Core Koala Habitat' as defined by SEPP44 occurs on the AWMF site.

Reptiles

One reptile species – Garden Skink (*Lampropholis delicate*) was recorded within the AWMF site, and four additional species recorded in the adjacent bushland – Fence Skink (*Cryptoblepharus virgatus*), Eastern Blue-tongue Lizard (*Tiliqua scincoides*), Red-bellied Black-snake (*Pseudechis porphyriacus*) and Black-bellied Snake (*Hemiapsis signata*). A total of 22 reptile species have been recorded in the locality on the LMCC fauna database (2000) and OEH wildlife atlas (October 2011). Reptile habitat overall is good within the forested parts of the AWMF site and larger study area, but the cleared open areas of the AWMF site support very limited habitat. However, areas were illegal dumping has occurred around the perimeter of the landfill site, and stockpiles of green waste on the landfill site are considered to provide refuge sites and foraging areas for reptiles (Murray *et al.*, 2012).

Amphibians

There are several small dams and leachate ponds within the AWMF site which provide habitat for frogs. The drainage line along the un-named creek near Wilton Road supports areas of ephemeral habitat for frogs, but would dry up during periods of low rainfall. Additional habitat for frogs on the AWMF site includes habitat trees which contain hollows utilised as sheltering sites for tree frogs. One amphibian species, the Red-backed Toadlet (*Pseudophryne coriacea*) was recorded at the AWMF site (Murray *et al.*, 2012).

6.5.2.4 Fauna – Sewer Pipeline Route

Niche (2012b) undertook a field survey of fauna along the sewer pipeline route which comprised a habitat-based assessment and incidental fauna observations (including tracks, scats and other traces).

Threatened and Migratory Fauna – Desktop Assessment and Field Survey

Niche (2012b) recorded 31 fauna species during the field assessment of the pipeline route (see **Appendix J** for details), none of which were threatened species. However, one of the species recorded by Niche, the White-bellied Sea Eagle (*Haliaeetus leucogaster*) is listed as a migratory species under the EPBC Act.

A total of 13 threatened fauna species were considered to have a low or moderate likelihood of occurring within the study area, based on previous records found during fauna database searches and giving consideration to the habitat requirements of these species, as listed in **Table** 6.20.

Niche (2012b) also considered that that two migratory bird species have a low or moderate likelihood of occurring within the study area, based on fauna database searches, as listed in **Table 6.21**.

Table 6.20: Threatened Fauna Potentially Occurring Along the Pipeline Route (Niche, 2012b)

Common Name	Scientific Name	Legal Status*		Likelihood of Occurrence	Potential Impact on Species or Habitat
		EPBC Act	TSC Act		
Birds					
Glossy Black Cockatoo	*Calyptorhynchus lathami*	-	V	Low-Moderate	Negligible
Little Lorikeet	*Glossopsitta pusilla*	-	V	Low-Moderate	Negligible
Masked Owl	*Tyto novaehollandiae*	-	V	Moderate	Negligible
Powerful Owl	*Ninox strenua*	-	V	Moderate	Negligible
Scarlet Robin	*Petroica multicolour*	-	V	Low-Moderate	Negligible
Varied Sittella	*Daphoenositta chrysoptera*	-	V	Moderate	Negligible
Mammals					
Eastern Bent-wing Bat	*Miniopterus schreibersii oceanensis*	-	V	Moderate	Negligible
East-coast Freetail-bat	*Mormopterus norfolkensis*	-	V	Moderate	Negligible
Greater Broad-nosed Bat	*Scoteanax rueppellii*	-	V	Moderate	Negligible
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Moderate	Negligible
Little Bent-wing Bat	*Miniopterus australis*	-	V	Moderate	Negligible
Squirrel Glider	*Petaurus norfolcensis*	-	V	Moderate	Negligible
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	-	V	Moderate	Negligible

* V = Vulnerable and E = Endangered under the Acts

Table 6.21: Migratory Bird Species Known and Potentially Occurring Along the Pipeline Route (Niche, 2012b)

Common Name	Scientific Name	Legal Status*			Likelihood of Occurrence	Potential Impact on Species or Habitat
		EPBC Act	TSC Act	Other		
Satin Flycatcher	*Myiagra cyanoleuca*	M	-	Bonn Convention	Moderate	Negligible
White-bellied Sea Eagle	*Haliaeetus leucogaster*	M	-	CAMBA	Known	Negligible

* M = Migratory under the EPBC Act; CAMBA = China-Australia Migratory Bird Agreement and Bonn Convention = Convention on the Conservation of Migratory Species of Wild Animals

As indicated in **Tables 6.20** and **6.21** the impact on these threatened and migratory fauna species and their potential habitats as a result of the proposed pipeline is considered negligible, especially given that the pipeline would be covered over, allowing regeneration of the vegetation and potential habitat removed.

Fauna Habitat Surveyed

Fauna habitats within the pipeline footprint are limited to essentially native and non-native herbaceous groundcovers with occasional low shrubs, particularly along Wilton Road. Reed and sedge vegetation occurred at creek crossings on Wangi and Wilton Roads. Although hollow-bearing trees occurred in close proximity to the pipeline footprint, none were actually observed within the pipeline footprint. The availability of habitat for the affected threatened fauna identified in **Table** 6.20 is therefore very limited within the pipeline footprint.

Less than 0.1ha of poor-moderate quality native vegetation would be affected by the proposed pipeline and up to 10 mature non-hollow-bearing trees would be either trimmed, sustain root damage or be felled to facilitate the works. No hollow-bearing trees would be removed.

Forested areas adjoining the proposed pipeline route are likely to provide a wide variety of sheltering habitat (in the form of hollows or nesting opportunities) and a range of food resource for both threatened and common native fauna (Niche, 2012b).

With regards to Koala habitat, Niche (2012b) found that the site of the proposed pipeline contains neither a viable population of Koalas nor 'Core Koala Habitat' as defined by SEPP 44 – Koala Habitat Protection.

6.5.3 Potential Impacts

The proposed expansion works at the AWMF and the construction of additional facilities such as the waste transfer station will result in impact to vegetation within the 8.55ha footprint (Murray *et al.*, 2012).

The proposed sewer pipeline works will result in the removal of approximately 1ha of mostly modified groundcover vegetation within the proposed 3m wide construction easement, the majority of which is exotic herbaceous groundcover and not substantial vegetation. Less than 0.1ha of the total 1ha comprises moderate quality native vegetation. Up to 10 mature non-hollowing bearing trees would require either removal, trimming (to provide access for machinery) or sustain damage to their root systems as a result of trenching works for the pipeline (Niche, 2012b). However, vegetation removal for the sewer pipeline is considered less significant than at the AWMF site as the pipeline route will promptly be re-vegetated once the pipeline has been installed.

Some potential construction impacts of the overall proposed works that will require mitigation measures include:

- Inadvertent damage to or removal of vegetation to be retained;
- Inadvertent spread of weeds and establishment of new weeds in disturbed areas; and
- Death or injury of wildlife due to the proposed works.

The potential impacts on EPBC and TSC Act listed threatened flora and fauna species due to the removal of this vegetation and habitat is discussed in the following sections.

6.5.3.1 Potential Impacts on EPBC Act Listed Species

The flora and fauna investigation conducted over the AWMF site and surrounds by Murray *et al.* (2012) determined that only a small number of the EPBC Act listed species (discussed in **Section 0**) are relevant to the proposed expansion areas on the AWMF site. The remaining species were either not observed during the flora and fauna investigations (Murray *et al*., 2012) or the AWMF site did not contain habitat that was suitable for these species.

The flora and fauna assessment by Niche (2012b) for the sewer pipeline route concluded that there would be negligible impacts on threatened species listed under the EPBC Act (as listed in **Tables 6.20** and **6.21**).

The relevant species that may be impacted by the overall proposed works and the results of the EPBC Act impact assessments on threatened species by Murray *et al.* (2012) and by Niche (2012b) are provided in **Table 6.22**.

Table 6.22: Summary of EPBC Act Impacts Assessment on Threatened Species (Murray *et al.*, 2012 and Niche, 2012b)

Common Name	Scientific Name	Occurrence in Lot 372	Occurrence in the Pipeline Route	Summary of Impact Assessment
Flora				
Black-eyed Susan	*Tetratheca juncea*	2,333 plants	Recorded in close proximity to the pipeline footprint, but not within	The majority of the plants (2,302 plants) on Lot 372 occur in the footprint of the proposed works on the AWMF site and would be destroyed. The plants along the pipeline route are located outside of the proposed disturbance area. **Conclusion: Significant impact on site population at the AWMF site but not local population**
Small-flower Grevillea	*Grevillea parviflora* ssp. *parviflora*	280 plants	Recorded in close proximity to the pipeline footprint, but not within	The plants are located outside of the proposed disturbance areas and would not be directly impacted by the works. **Conclusion: No direct impacts**

Common Name	Scientific Name	Occurrence in Lot 372	Occurrence in the Pipeline Route	Summary of Impact Assessment
Charmhaven Apple	*Angophora inopina*	Not recorded in Lot 372, but recorded in adjacent Lot 373	Recorded in close proximity to the pipeline footprint, but not within	The plants are located outside of the proposed disturbance areas and would not be directly impacted by the works. **Conclusion: No direct impacts**
Fauna				
Grey-headed Flying-fox	*Pteropus poliocephalus*	Recorded in the general locality	Not recorded along the pipeline route but has been recorded in the general locality	The proposed works on the AWMF site would impact approximately 8.55ha of foraging habitat. The proposed works along the sewer pipeline route would clear approximately 1ha of foraging habitat; however this would be promptly reinstated once installation works are complete. **Conclusion: No significant impact on local population**
Large-eared Pied Bat	*Chalinolobus dwyeri*	Recorded in the general locality	Not recorded along the pipeline route but has been recorded in the general locality	The proposed works on the AWMF site would impact approximately 8.55ha of foraging habitat. The proposed works along the sewer pipeline route would clear approximately 1ha of foraging habitat; however this would be promptly reinstated once installation works are complete. **Conclusion: No significant impact on local population.**
Listed migratory bird species	-	Several species recorded on site and in adjacent Lot 373 (see **Table 6.19**)	One specie recorded along the pipeline route (see **Table 6.21**)	The proposed works on the AWMF site would impact approximately 8.55ha of foraging habitat. The proposed works along the sewer pipeline route would clear approximately 1ha of foraging habitat; however this would be promptly reinstated once installation works are complete. **Conclusion: No significant impact on local populations**

As indicated in **Table 6.22**, of the EPBC Act listed species, only one was determined to be significantly impacted by the proposed development, *Tetratheca juncea*. Potential impacts as a result of the impact to approximately 8.55ha of remnant native vegetation for the proposed expansion to the AWMF are considered to be more significant than the removal of approximately 1ha of vegetation (comprising less than 0.1ha of native vegetation communities, the majority being exotic herbaceous groundcover) associated with the sewer pipeline works.

The potential impacts of the proposed expansion works at the AWMF for *Tetratheca juncea*, the Grey-headed Flying-fox, Large-eared Pied Bat and listed migratory birds as a result of the impact to approximately 8.55ha of remnant native vegetation are discussed below.

Tetratheca juncea (Black-eyed Susan)

DSEWPaC (2011a) recently released referral guidelines for *Tetratheca juncea* that provide advice on whether a proposed activity should be referred under the EPBC Act. Based on these guidelines, the AWMF site can be considered an important population, as there are greater than 1,000 clumps (2,333 plants) at an estimated plant clump density of 340 clumps/ha. The AWMF site is also located within an area of important habitat (as defined in Map 4a of the guidelines for the central coast region). The location of *Tetratheca juncea* over the AWMF site and the adjacent Lot 373 is shown in **Figure 6.11**.

The clearing of the proposed expansion area in Lot 372 would result in the loss of 2,302 plants or 98.6% of the population recorded within Lot 372 (Murray et al., 2012). Hence in accordance with the guidelines (DSEWPaC, 2011a) an EPBC Referral was prepared and submitted to DSEWPaC on 18 May 2011 (Cardno, 2011c). Following formal exhibition of the referral and consideration by the Minister, the proposed actions were deemed to be a controlled action on 17 June 2011. A copy of the Minister's EPBC referral decision is provided in **Appendix A**.

A request for variation to the proposal to include the proposed 3.4km rising main and additional facilities on site was made to DSEWPaC on 29 November 2011, which included an update of Cardno's referral report (Cardno, 2011d). The proposed variation, which has been assessed within this EA document, was accepted by the minister on 22 December 2011. A copy of the variation decision notice is provided in **Appendix A**. It should be noted that the updated referral report revised the area in hectares of remnant native vegetation proposed for removal from the site and also revised the number of *Tetratheca juncea* plants proposed for removal. Note that only the original referral report and not the updated version is provided on DSEWPaC's website (DSEWPaC, 2011b) and hence there is a discrepancy in the numbers which were made publicly available and those presented in this document.

Lot 373, immediately east of the subject site, was also surveyed for *Tetratheca juncea* and was found to contain 12,489 plants as indicated on **Figure 6.11**. The high density of plants within these two lots suggests that the entire 14,822 plants would be one population (Murray *et al.*, 2012). Clearly this population would not be confined to the surveyed area and in most areas plants could be seen to be continuing into the adjoining habitat.

A GIS analysis shows that the AWMF site is located in 530ha of continuous vegetation which is connected across local roads to another 1,000ha. Driscoll (2003) showed that the majority of records for *Tetratheca juncea* were from Coastal Plains Smooth-barked Apple Woodland or Coastal Plains Scribbly Gum Woodland communities as classified in NPWS (2000). The NPWS (2000) vegetation map shows that the aforementioned 1,530ha of vegetation is almost entirely made up of these two communities and so would be suitable habitat for *Tetratheca juncea*.

The *Tetratheca juncea* plants recorded in the AWMF site would be part of an important population (Murray *et al.*, 2012).

The loss of up to 2,302 plants and the associated habitat from the immediate population of 14,822 plants and the much wider population is therefore likely to result in a long-term reduction in this important population.

Pteropus poliocephalus (Grey-headed Flying-Fox)

While the Grey-headed Flying-fox was not recorded within the AWMF site during fauna surveys, the species is considered highly likely to utilise the forested parts of the AWMF site as a component of its extensive foraging range (Murray *et al*., 2012). Actions likely to adversely affect the life cycle of the Grey-headed Flying-fox are:

- Loss of foraging habitat (remnant forest); and
- Disturbance to roost and breeding sites.

A draft National Recovery Plan has been prepared for this species by DECCW (2009a). Criteria within the Plan would qualify the AWMF site as either "critical" or "essential" foraging habitat for the Grey-headed Flying-fox, due to flowering of eucalypt and angophora tree species during the period September to May. The nomadic nature of this species suggests that the population visiting the AWMF site would utilise a much greater area to gain sufficient foraging resources throughout the year. Within the context of the normal foraging range of an individual Grey-headed Flying-fox which equates to 20km per night on average (DECCW, 2009a), the proposed action will not result in a significant reduction in foraging habitat, and is therefore unlikely to constitute a significant impact (Murray *et al.*, 2012).

The population of Grey-headed Flying-fox that potentially utilise habitats within the AWMF site and surrounds cannot be considered an important population in itself; however, it can be considered to be part of a larger important population that comprises genetically similar individuals. No populations of the species occupy the AWMF site on a permanent basis and the AWMF does not support a camp or roosting site. The largest known camps within a 50km radius of the AWMF site include Wambina Nature Reserve and Jilliby Conservation Area on the Central Coast and Blackbutt Reserve near Newcastle (Murray *et al.*, 2012).

The proposed impact to approximately 8.55ha of foraging habitat at the AWMF site is unlikely to significantly affect the abundance of this resource within the home range of the local population (25-50km radius), nor is it considered to significantly affect the life cycle of the local population, such that the viable local population is likely to be placed at risk of extinction. There would be no disturbance to roost and or breeding sites by the proposed activity, and as such the proposed activity is unlikely to impact (either directly or indirectly) on an important population of the Grey-headed Flying-fox, as determined by the species impact assessment by Murray *et al.* (2012).

Chalinolobus dwyeri (Large-eared Pied Bat)

The Large-eared Pied Bat was not detected within the landfill site by surveys for this species. However, the species may utilise the aerial space above the forested parts of the landfill site as a component of its foraging range. Given the foraging range of this species, the study site would comprise a small component of a much larger foraging area for any individuals that visit the site. As such, the proposed action will not result in a significant reduction in foraging habitat, and is therefore unlikely to constitute a significant impact.

The population of Large-eared Pied Bat that utilise habitats within the landfill site cannot be considered as an important population in itself, however it can be considered to be part of a larger "important population" that comprises genetically similar individuals. The likely extent of habitat modification associated with the proposed additions to the AWMF is the clearing of ground within the impacted footprint area of 8.55 hectares. There would be a net loss of foraging habitat by the proposed action. Therefore, the proposed action will reduce the availability of habitat for the species, but this is unlikely to result in a decline in the important population. The proposal is unlikely to reduce the area of occupancy for the local population of the species, nor is it considered to result in long-term decrease in population size of an important population.

The Large-eared Pied Bat roosts in caves or similar structures. No roost or breeding sites suitable for the Large-eared Pied Bat occur on the study site, so this habitat would not be disturbed.

Whilst a proportion of the landfill area supports infestations of invasive species such as Lantana and Bitou Bush, these invasive species would not impact significantly upon the habitat of the Large-eared Pied Bat. The proposed expansion of the Awaba waste facility is unlikely to introduce disease that may significantly impact on an important population of the Large-eared Pied Bat.

Overall, the proposed action (expansion of the Awaba waste facility) is unlikely to impact (either directly or indirectly) on an important population of the Large-eared Pied Bat.

Listed Migratory Bird Species

In addition to the bird species recorded as part of the fauna field surveys undertaken by Murray *et al.* (2012) listed in **Table 6.19**, a number of additional migratory bird species that could potentially occur at the AWMF site were also noted (see **Appendix I** for details). However, Murray *et al.* (2012) found that the proposed action to clear ground within the impacted footprint area of 8.55 hectares would not substantially modify, destroy or isolate an area of important habitat of any migratory bird species that occurs or has the potential to occur at the AWMF site. The habitat to be cleared is continuous with a much larger forest fragment in excess of 1,000ha, such that impact to approximately 8.55ha at the AWMF site will not substantially modify or destroy an area of important habitat for any migratory species.

Very few species would actually breed in the proposed AWMF expansion area and as such, the proposed works would not seriously disrupt the lifecycles of any potentially impacted migratory species. Overall, the loss of habitat within the 8.55ha AWMF footprint is not considered to significantly impact upon the feeding, migration or resting behaviour of the identified species. Further details are provided in **Section A3.1.2, Appendix I**.

Potential Indirect and Long-Term Impacts

The federal department of environment (DSEWPaC) requested additional consideration of potential indirect and long term impacts to individuals of those threatened species that occur outside of the development footprint. Consideration of long term impacts can be assessed by comparison of the existing operation to current populations of threatened species. Populations of threatened species, particularly plants, occur within very close proximity to the boundary of the existing operation, which indicate limited direct or indirect impacts on those populations. For example, populations of *Tetratheca juncea* occur within 5 metres of the edge of the existing operation, which suggests edge effects are limited. For fauna populations, no obvious direct or indirect impacts were considered to operate.

The removal of existing vegetation for the proposed expansion will create a new boundary to the adjoining Lot 373. Considering the presence and distribution of flora and fauna species during existing operations at the site, it is likely that effects from the proposed operation will be restricted to a relatively small area (i.e. likely to be less than 5 metres) from the new site boundary. Additional mitigation measures are discussed in **Section 6.5.4**. Improvements to water management and edge effects adopted for the new operation will ensure edge disturbances will be minimal. Disturbances to native vegetation and fauna habitat (such as dumping of domestic refuse in adjoining bushland) have occasionally occurred, and should be controlled by restrictions on access to motor vehicles.

An additional potential impact on flora and fauna is introduction and establishment of Exotic Rust Fungi on plants of the Myrtaceae family, listed as a Key Threatening Process under the *NSW Threatened Species Conservation Act 1995*. This fungus has been detected on the Central Coast of NSW and could potentially be present in, or spread to the City of Lake Macquarie. In particular, if the fungus is present in any vegetation to be cleared, additional precautions will be required when disposing of the cleared vegetation. Mitigation measures for this threatening process are described in Section 6.5.4.4.

6.5.3.2 *Potential Impacts on TSC Act Listed Species*

The flora and fauna assessment by Niche (2012b) for the sewer pipeline route concluded that there would be negligible impacts on threatened species listed under the TSC Act (as listed in **Table 6.20**). As the scale of the proposal pipeline works is very small, Niche (2012b) considers that none of the habitat requirements of the threatened species listed in **Table 6.20** would be affected by the proposed pipeline and the potential for loss of limiting habitat for threatened species along the pipeline route is considered low.

Table 6.23 indicates the TSC Act listed species that were identified for impact assessment by Murray *et al.* (2012) due to the proposed works on the AWMF site.

Table 6.23: TSC Act Listed Threatened Species Records (Murray *et al.*, 2012)

Common Name	Scientific Name	Habitat Present	Recorded Location / Potential to Occur
Flora			
Black-eyed Susan	*Tetratheca juncea*	Yes	Recorded on Lot 372
Small-flower Grevillea	*Grevillea parviflora* ssp. *parviflora*	Yes	Recorded on Lot 372
Bynoe's Wattle	*Acacia bynoeana*	Yes	Low potential to occur
Charmhaven Apple	*Angophora inopina*	Yes	Low potential to occur
Leafless Tongue-orchid	*Cryptostylis hunteriana*	Yes	Low potential to occur
Fauna			
East-coast Freetail Bat	*Mormopterus norfolkensis*	Yes	Recorded on Lot 372
Eastern Bent-wing Bat	*Miniopterus schreibersii oceanensis*	Yes	Recorded on Lot 373
Little Bent-wing Bat	*Miniopterus australis*	Yes	Recorded on Lot 373
Squirrel Glider	*Petaurus norfolcensis*	Yes	Recorded on Lot 373
Varied Sitella	*Daphoenositta chrysoptera*	Yes	Recorded on Lot 373
Grey-headed Flying-fox	*Pteropus poliocephalus*	Yes	High potential to occur
Little Lorikeet	*Glossopsitta pusilla*	Yes	High potential to occur
Masked Owl	*Tyto novaehollandiae*	Yes	High potential to occur
Powerful Owl	*Ninox strenua*	Yes	High potential to occur
Eastern Falsistrelle	*Falsistrellus tasmaniensis*	Yes	Medium potential to occur
Greater Broad-nosed Bat	*Scoteanax rueppellii*	Yes	Medium potential to occur

The Threatened Species Impact Assessments undertaken by Murray *et al.* (2012) for the species listed in **Table 6.23** are provided in **Appendix I**.

Details regarding the potential impact of the proposed expansion works at the AWMF on *Tetratheca juncea*, Grey-headed Flying-fox (*Pteropus poliocephalus*) and Large-eared Pied Bat (*Chalinolobus dwyeri*) are provided in **Section 6.5.3.1**. **Table 6.24** summaries the findings of the remaining Threatened Species Impact Assessments undertaken by Murray *et al. (*2012).

Table 6.24: Summary of Potential Impacts on TSC Act Listed Threatened Species (Murray *et al.*, 2012)

Common Name	Scientific Name	Description of Species Distribution and Habitat	Actions Likely to Affect the Species	Further Comments	Significance
East-coast Freetail Bat	*Mormopterus norfolkensis*	Recorded on the boundary of the AWMF site during investigations. Locality records also exist based on surveys conducted on adjoining land and records held on the OEH fauna atlas and LMCC fauna database (current to October 2011).	▪ Loss of foraging habitat (remnant forests and woodlands); and ▪ Clearing of habitat trees utilised as roost and breeding sites.	The proposed activity will result in a net reduction of foraging habitat (tree canopy and associated reduction in aerial insects) within the AWMF site. The clearing of vegetation at the site may result in a reduction of potential roost and breeding sites for the species.	Compared to the extent of suitable habitat in the locality, the proposed clearing of vegetation at the AWMF site is unlikely to affect the life cycle of the local population. The clearing of potential habitat trees which may support roost sites for this species is unlikely to have an adverse effect on the viability of the local population.
Eastern Bent-wing Bat, Little Bent-wing Bat and Large-eared Pied Bat	*Miniopterus schreibersii oceanensis, Miniopterus australis* and *Chalinolobus dwyeri*	None was recorded at the AWMF site during investigations, but all have been recorded in the locality (OEH fauna atlas – 2011/2012 and LMCC Fauna database – 2000).	▪ Clearing of native vegetation which provides foraging resources for both species; ▪ Disturbance to roost sites (caves); and ▪ Impact of urban lighting which can draw flying insects away from areas of remnant vegetation into urban areas.	All species roost in caves or similar structures and forage over aerial spaces for flying insects. No roost habitat exists on the AWMF site for any species. All species prefer to forage widely for their dietary requirements. Urban lighting impacts from the proposed works are not anticipated to significantly affect these species.	The proposed removal of remnant native vegetation at the AWMF site is unlikely to have an adverse effect on a component of the life-cycle of each species such that a viable local population is likely to be placed at risk of extinction.
Squirrel Glider	*Petaurus norfolcensis*	Not recorded within the AWMF site during investigations, but was recorded on the adjoining Lot 373 and has been observed in the locality during previous fauna surveys. Remnant native vegetation occurring at the site is likely to comprise a proportion of the home range of a local population of the species.	▪ Clearing of foraging resources; ▪ Fragmentation of habitat and isolation of populations; and ▪ Removal of den trees as roost and breeding sites.	The proposed activity will result in a reduction in foraging resources for this species, as two vegetation communities at the site are likely to support moderate densities of gliders – (Freeman's Peppermint-Apple Bloodwood Forest and Sugarloaf Lowlands Bloodwood-Apple Scribbly Gum Forest). The proposed action is likely to result in a loss of potential or	Given the extent of habitat to be impacted (8.55ha) compared to the extent of adjoining suitable habitat in the locality (in excess of 1,500ha), the loss of habitat on the AWMF site is unlikely to adversely affect the life cycle of the viable local population.

Common Name	Scientific Name	Description of Species Distribution and Habitat	Actions Likely to Affect the Species	Further Comments	Significance
				actual shelter and breeding sites for the species. However, within the AWMF site, the density of habitat trees suitable for the Squirrel Glider is low (an average of 2.0 habitat trees/ha).	
Varied Sitella	*Daphoenositta chrysoptera*	Not recorded in the AWMF site during investigations; however, recorded on the adjacent Lot 373 and recorded in the locality. May frequent the AWMF site as part of its larger foraging range. The AWMF site contains suitable areas of foraging habitat for the species.	▪ Loss of foraging habitat (remnant forest); and ▪ Decline in habitat cover and quality.	Vegetation clearing may lead to potential loss of nesting sites. The species is known to build nests high in the canopy of living trees and use the same nest repeatedly over several years.	Given the extent of habitat to be impacted (8.55ha) compared to the extent of adjoining suitable habitat in the locality (in excess of 1,500ha), the proposed impact within the 8.55ha footprint to remnant forest is not considered to significantly affect the life cycle of the local population, such that the viable local population is likely to be placed at risk of extinction.
Little Lorikeet	*Glossopsitta pusilla*	Not recorded at the AWMF site during investigations; however, the species is known to occur in the locality based on published records. Although there are breeding records of the species in the Hunter Valley (HBOC, 2009), with the nearest known record at Quorrobolong and Kurri Kurri, no breeding records are known for the City of Lake Macquarie to suggest the AWMF site supports breeding habitat.	▪ Loss of foraging habitat (remnant forest); and ▪ Loss of breeding sites (mature trees with hollows).	The proposed activity will reduce the extent of foraging habitat available in the locality. The proposed action will result in the clearing of trees that may be considered potential nesting sites for the species.	The remnant vegetation and fauna habitat presently existing on the AWMF site is continuous with an extensive forest fragment in excess of 1,500ha. As such, the proposed removal of vegetation from the AWMF site will not significantly affect the life cycle of a local population, such that the viable local population is likely to be placed at risk of extinction.
Masked	*Tyto*	Neither was recorded at the	▪ Loss of foraging habitat	The proposed impact to remnant	The remnant vegetation and fauna

Common Name	Scientific Name	Description of Species Distribution and Habitat	Actions Likely to Affect the Species	Further Comments	Significance
Owl and Powerful Owl	*novaehollandiae* and *Ninox strenua*	AWMF site during investigations; however, both species are known to occur in the locality based on published records.	(remnant forest); and ▪ Disturbance or loss of roost and breeding sites.	forest within the 8.55ha footprint would result in the loss of foraging habitat for the species. No confirmed roost or nest sites were identified for either species within the AWMF site during investigations; however, four habitat trees on Lot 372 were identified as potentially suitable nesting trees for both species. The proposed AWMF expansion would cause the removal of possibly three of the four trees.	habitat presently existing on the AWMF site is continuous with an extensive forest fragment in excess of 1,500ha. The loss of remnant forest and the loss of potential nest/roost trees at the AWMF site are not considered to significantly affect the life cycle of the local population of either species such that the viable local population is likely to be placed at risk of extinction.
Eastern Falsistrelle and Greater Broad-nosed Bat	*Falsistrellus tasmaniensis* and *Scoteanax rueppellii*	These two species of microchiropteran bats with similar habitat requirements and comparable echolocation calls have been recorded in the locality and could potentially occur on the AWMF site. Each of these species would utilise the aerial space above the AWMF site for foraging purposes, but also may utilise tree hollows for roost and nest sites.	▪ Loss of foraging habitat (remnant forests and woodlands); and ▪ Clearing of habitat trees utilised as roost and breeding sites.	The proposed activity will result in a net reduction of foraging habitat (tree canopy and associated reduction in aerial insects) within the AWMF site. The clearing of vegetation at the AWMF site may result in a reduction of potential roost and breeding sites for these species.	Foraging resources for these species are relatively abundant within stands of forest and woodland adjoining the AWMF site. Clearing of habitat for the proposal will not result in fragmentation of habitat or isolation from adjoining areas and the proposed activity is therefore unlikely to effect the long term survival of either species in the locality. Compared to the extent of suitable habitat in the locality, the proposed clearing of vegetation at the AWMF site is unlikely to affect the life cycle or viability of the local population of either species.
Bynoe's Wattle	*Acacia bynoeana*	Not recorded on the AWMF site during investigations; however, 68 plants were recorded on adjacent	No plants found to occur on the AWMF site so the species would not be directly or	None.	No direct impact.

Common Name	Scientific Name	Description of Species Distribution and Habitat	Actions Likely to Affect the Species	Further Comments	Significance
		Lot 373.	indirectly impacted by the action.		
Charmhaven Apple	*Angophora inopina*	Not recorded on the AWMF site during investigations; however, 158 plants were recorded on adjacent Lot 373.	No plants found to occur on the AWMF site so the species would not be directly or indirectly impacted by the action.	None.	No direct impact.
Leafless Tongue-orchid	*Cryptostylis hunteriana*	Not recorded on the landfill site during investigations; although a locality record exists for the adjoining Lot 373.	No plants were located on the AWMF site so the species would not be directly or indirectly impacted by the action.	None.	No direct impact.

6.5.4 Mitigation Measures

The following section provides an indication of recommended measures to mitigate negative impacts on flora and fauna as a result of the project. These mitigation measures, particularly biodiversity offsetting, are expected to adequately address the negative impacts on flora and fauna associated with the proposal.

6.5.4.1 Biodiversity Offset Considerations and BioBanking Assessment

The development proposal is subject to the 'Improve or Maintain' principle in respect to impacts on threatened biodiversity as listed under the TSC Act. This means an action should not result in a net loss of a species and its habitat, and should preferably result in a net gain. This can be accomplished by setting aside in-perpetuity parts of populations and habitats on land that offsets the loss from the action. Historically this has been a fairly subjective process but BioBanking is now available and is being used as a tool to quantify offsets.

Niche (2012a) prepared a biodiversity offsetting assessment for the site (**Appendix K**). The report provides recommendations of mitigation measures that should be employed to offset the negative impacts of the development on threatened flora and fauna, with particular emphasis on *Tetratheca juncea*.

Previous offsetting investigations conducted by Niche for the site in 2011 resulted in a decision being made by LMCC to formalise a BioBanking agreement for the proposed works. Utilisation of the BioBanking pathway will allow LMCC to uphold the "maintain or improve" principle and will also facilitate the approval of the development.

Due to the distribution of *Tetratheca juncea* over the AWMF site, it is not possible to avoid or minimise impacts on this species due to the AWMF expansion works, which will require the removal of 2,302 *Tetratheca juncea* plants. No other threatened flora species were located within the direct footprint of the works and no threatened fauna species were considered to be significantly impacted by the proposal. Biodiversity offsets are also required for the native vegetation communities to be impacted, although it is noted that none of these communities are EECs.

The part of Lot 372 that will be affected by the proposed development is considered as the *Development Site*. It is proposed to utilise the remainder of Lot 372, a portion of Lot 373 and an additional suitable area of land (yet to be determined) as the proposed Awaba *BioBank Site*, which provides the credits for offset. The location of Lots 372 and 373 are shown in **Figure 6.10**, and further figures providing an indication of the location and vegetation present on the proposed Development Site and known areas of the BioBank Site are provided in **Appendix K** (Figures 3 - 6 in Niche [2012a]). Note that the proposed sewer pipeline from the AWMF is to be contained wholly within the road reserve adjacent to Lots 372 and 373, and as such, this part of the development will not be occurring on biodiversity offset land.

Niche (2012a) have utilised the *BioBanking Assessment Methodology (BBAM)* (DECCW 2009a) for the purposes of estimating the offsetting requirement for the project. The following scenarios were run in the *BioBanking Credit Calculator* (Version 2.0) as part of the assessment:

- Development Site – Part of Lot 372, (DP 723259):
  - 7.2 hectare impact on native vegetation, noting that the whole of the development area covers 8.55 hectares (**Appendix I**), 1.35 hectares of which is non-assessable land under the *BBAM*; and
  - Removal of 2,302 *Tetratheca juncea* individuals (threatened species);
- Known areas of the proposed BioBank Site (Offset Site) – (i.e. part of Lot 372 and part of Lot 373 (DP 723259)):
  - In-perpetuity conservation and management of 34.46 hectares of native vegetation;
  - In-perpetuity conservation and management of 11,632 *Tetratheca juncea* individuals; and
  - In-perpetuity conservation and management of additional known populations of the threatened species *Acacia bynoeana*, *Angophora inopina* and *Grevillea parviflora* subsp. *parviflora*.

The result of the Development Site (Lot 372) BioBanking assessment conducted by Niche (2012a) was that 392 Ecosystem Credits and 33,853 *Tetratheca juncea* Species Credits were calculated as being required to offset the Lot 372 proposal. The results of assessment of the known parts of the proposed BioBank Site (i.e. part of Lot 372, and part of Lot 373) assessment were that:

- 153 Ecosystem Credits of the required vegetation types will be generated on these areas of the proposed BioBank Site, with an additional 27 Ecosystem credits for vegetation of other types also being generated;
- An additional 239 Ecosystem Credits of the required vegetation types will need to be provided by incorporation of additional suitable land into the proposed BioBank site;
- 69,792 *Tetratheca juncea* credits will be generated, well in excess of the number which are required to meet the improve or maintain outcome for this species.

Table 6.25 and **Table 6.26** provide a summary of the biodiversity credits and area in hectares for each species and vegetation community type. These tables demonstrate that the proposed BioBanking Site is capable of sufficiently offsetting proposed impacts on *Tetratheca juncea*, and partially providing the Ecosystem Credits required for other vegetation types through suitable, in-perpetuity conservation and management. Additional lands will be acquired by LMCC and incorporated into the proposed BioBank Site to provide the further 239 required Ecosystem Credits.

Upon establishment of the proposed BioBank Site, 392 Ecosystem Credits of the required vegetation types and 33,853 *Tetratheca juncea* Species Credits will be retired within the BioBanking Scheme in order to achieve an “improve or maintain” outcome for biodiversity.

Table 6.25: Ecosystem Credits for BioBanking (Niche, 2012a)

Revised Biometric Vegetation Type	Total Ecosystem Credits REQUIRED	Area (ha)
Development Site (Lot 372)		
HU610: Scribbly Gum – Red Bloodwood	260	5.04
HU621: Smooth-barked Apple – Red Bloodwood	132	2.16
Total	**392**	**7.2**
Revised Biometric Vegetation Type	**Total Ecosystem Credits CREATED**	**Area (ha)**
Known areas of BioBank Site (Part of Lots 372 and Lot 373)		
HU508: Blackbutt - Pink Bloodwood	25	4.85
HU610: Scribbly Gum - Red Bloodwood	67	10.01
HU621: Smooth-barked Apple - Red Bloodwood	86	19.21
HU622: Smooth-barked Apple - Sydney Peppermint - Turpentine	2	0.29
Total	**180**	**34.36**

Table 6.26: Species Credits for BioBanking (Niche, 2012a)

Species	Individuals Lost	Species Credits REQUIRED
Development Site (Lot 372)		
Tetratheca juncea	2,302	33,853
Species	**Individuals Present**	**Species Credits CREATED**
Known areas of BioBank Site (Part of Lots 372 and Lot 373)		
Acacia bynoeana	68	408
Angophora inopina	158	948
Grevillea parviflora subsp. *parviflora*	882	5,292
Tetratheca juncea	11,632	69,792

As a component of finalising the BioBank Agreement, LMCC would provide DP&I with a *BioBank Site Management Plan* that commits the proposed Awaba BioBank Site to in-perpetuity management and a fund deposit calculated on this basis. This will include identification of all areas of Land which will make up the BioBank Site. The required management actions would be determined in consultation with OEH and would be estimated using Part A of the BioBanking Credit Pricing Spreadsheet (OEH, 2011c). The management of the site would be registered on the Title of the land and, as such, the offset would be secured in perpetuity.

6.5.4.2 *Vegetation Management Plan*

It is recommended that a Vegetation Management Plan (VMP) be prepared and approved by LMCC prior to implementation of the proposed works. The VMP should include details pertaining to procedures for clearing, landscaping and revegetation/rehabilitation works that are planned for the AWMF site during the construction, operational and post-closure phases and also immediately following completion of the installation of the sewer pipeline. The VMP should incorporate a Vegetation Clearing Protocol and the following key mitigation measures:

- Locally-sourced seeds for direct seeding and/or propagation of tubestock should be collected prior to clearing;
- Clearing should be undertaken in a staged process consistent with operational requirements;
- Clearing must not be undertaken in any area apart from those designated for operational purposes;
- Trees and vegetation to be retained should be fenced to avoid unnecessary clearing, including along the sewer pipeline route to avoid accidental damage by machinery during trenching works;
- Prior to removal of hollow-bearing trees, hollows should be checked for fauna. All fauna found should be relocated to the offset area;
- Locally occurring native species should be used for plantings/landscaping. These areas would be established and planted as early as possible in the construction phase;
- Fencing should be used to delineate rehabilitation/revegetation areas;
- Progressive revegetation and rehabilitation of landfill cells that have been exhausted should be undertaken as early as possible;
- Rehabilitation and revegetation should be undertaken along the edges of proposed leachate ponds to provide potential habitat for native fauna; and
- Ongoing vegetation condition monitoring (including the presence of weeds) should be undertaken throughout all phases of the proposed works. Any identified issues should be addressed as soon as practicable.

Where possible, the VMP should be prepared in accordance with *Controlled Activities: Guidelines for Vegetation Management Plans* (NSW Office of Water, 2010a). The criteria specified in this guideline are particularly relevant to the riparian corridor in the vicinity of the unnamed waterway in the southern portion of the site. There should only be minimal impacts on the riparian corridor at the site if appropriate mitigation measures are implemented (as specified in this Environmental Assessment), including the delineation and enforcement of a 30m works buffer around the watercourse (measured from its centreline).

A Weed Management Sub-Plan should also be incorporated into the VMP, which, as a minimum should include the following mitigation measures:

- Wherever possible, the use of herbicides should be kept to an absolute minimum;
- Existing weed infestations on site should be managed prior to commencement of the proposed works;

- Targeted monitoring and control of invasive species that are known to compete with threatened species/EECs should be undertaken where possible;
- Plant, trucks and other vehicles should be inspected for soil and weeds and cleaned as necessary before moving to or from the works areas;
- The volume of topsoil introduced from off-site areas should be minimised; and
- Drainage and run-off that may otherwise mobilise weeds or nutrients should be managed appropriately.

The full suite of mitigation measures would be detailed in the VMP.

To avoid dispersal of Exotic Rust Fungi to other parts of the Lake Macquarie LGA and ameliorate consequent impacts on plants of the Myrtaceae family, native vegetation mulched during the clearing process should be contained on site, unless it can be demonstrated by suitably qualified personnel that Exotic Rust Fungi is not present, in which case the vegetation material may be transported off site once mulched.

6.5.4.3 Fauna Management Plan

It is recommended that a Fauna Management Plan (FMP) be prepared and implemented prior to commencement of the proposed works. The FMP should provide a protocol for responding to the detection and relocation of native fauna present in trees, hollows and logs that lie within the proposed areas for clearing. Details regarding the most appropriate season(s) to undertake clearing with regard to reducing disturbance to fauna (especially nestlings) should also be included. The FMP should be prepared in accordance with species-specific management plans for threatened species, where available (**Table 6.27**). The FMP should incorporate details regarding the proposed management of pest species during the proposed works. This should continue throughout the operational phase of the proposed works.

6.5.4.4 Species-Specific Mitigation Measures

In addition to the other mitigation measures discussed in **Section 6.5.4**, *Recovery Plans*, *Threat Abatement Plans* or *Priority Action Statements* should be followed for listed threatened species (where they have been prepared and where applicable). **Table 6.27** outlines each of the listed species and associated management plans that have been prepared.

Table 6.27: Listed Threatened Fauna Species and Associated Recovery Plans or Priority Action Statements

Common Name	Scientific Name	Associated Plan/Statement
Black-eyed Susan	*Tetratheca juncea*	*Lake Macquarie Tetratheca juncea Conservation Management Plan* (Payne, 2000) *Threatened Species Recovery Plan Tetratheca juncea and Acacia bynoeana* (HLA-Envirosciences, 2007), carried out for these species at the nearby Eraring Power Station, and may be useful as a reference
Grey-headed	*Pteropus*	*Draft National Recovery Plan for the Grey-headed Flying-fox*

Common Name	Scientific Name	Associated Plan/Statement
Flying-Fox	*poliocephalus*	*Pteropus poliocephalus* (DECCW, 2009a)
Bynoe's Wattle	*Acacia bynoeana*	*Threatened Species Recovery Plan Tetratheca juncea and Acacia bynoeana* (HLA-Envirosciences, 2007), carried out for these species at the nearby Eraring Power Station, and may be useful as a reference
Powerful Owl	*Ninox strenua*	*Recovery Plan for the Large Forest Owls: Powerful Owl (Ninox strenua), Sooty Owl (Tyto tenebricosa), Masked Owl (Tyto novaehollandiae)* (DEC, 2006c)
Masked Owl	*Tyto novaehollandiae*	*Recovery Plan for the Large Forest Owls: Powerful Owl (Ninox strenua), Sooty Owl (Tyto tenebricosa), Masked Owl (Tyto novaehollandiae)* (DEC, 2006c)

6.6 Air Quality and Odour

Key construction phase impacts will relate primarily to air quality and dust emissions from construction trucks and plant/equipment, whilst no construction-related sources of odour have been identified.

Operational odour impacts were modelled and results indicate that odour concentrations will be below the detection threshold of 1 OU within 500m-900m of the active tipping face (depending on the model scenario). Odour impacts associated with the sewer pipeline would only occur if a significant leak occurred in the pipeline or during processing of received waste waters.

In terms of air quality, model results indicate that NO_2 concentrations will be well below the assessment criteria and are unlikely to be substantial in the areas surrounding the AWMF site in the operational phase. Other compounds, namely CO, VOCs, NO_x and SO_2 are likely to only be present in insignificant concentrations.

No air quality impacts due to the sewer pipeline or the ancillary proposed facilities at the AWMF site are anticipated during the operational phase. Dust impacts are anticipated at times during the operational phase of the works, however modelling predictions for the construction and operational scenario indicate that the maximum predicted 24-hour PM_{10} concentration at a residence is 7.1 µg/m^3 which is well below the assessment criteria of 50 µg/m^3.

6.6.1 Introduction

The sections below examine the existing environment in the context of air quality and odour, and consider the potential impacts of the construction and operational phases of the proposed additions to the AWMF on these environmental components. Mitigation measures to reduce impacts on air quality and odour have also been recommended.

PAE Holmes conducted an Air Quality and Odour Assessment (PAE Holmes, 2012) and the assessment findings have been incorporated into this section. The full assessment document is provided as **Appendix L**.

During future operations of the expanded landfill, odour emissions can be expected primarily from the active tipping face, with lower emissions from leachate storage ponds and intermediate cover areas. It is anticipated that the additional facilities proposed at the AWMF, including the waste transfer station and additional reuse centre, wheel wash facility, access road, and the underground sewer pipeline transferring leachate off site will have negligible impacts on odour compared to the active tipping face. Hence the primary focus of the air quality and odour assessment is on the expansion to the landfill area.

6.6.2 Existing Environment

6.6.2.1 Climate

Climatic data collected over a 147 year period is available from the Australian BoM monitoring station located at Newcastle (Nobbys Signal Station AWS 061055). This data provides information on the long-term average values of climatic elements such as temperature, humidity, rainfall and the number of rain days per year. This station is the closest station to the AWMF site with a full record of climate data.

It should be noted that the water quality and quantity assessments and subsequently the leachate model (detailed in **Sections 6.3** and **6.4**, respectively) were undertaken using rainfall and evaporation data from the nearest BoM station in Toronto (61322), located approximately 4km from the AWMF site. However, this station did not have a full record of climate data; hence the Nobbys Signal Station AWS 061055 was used to obtain climate data by PAE Holmes.

The annual average maximum and minimum temperatures experienced at the Newcastle weather station are 21.8°C and 14.2°C, respectively. The data indicates that January is the hottest month with an average maximum temperature of 25.6°C, whilst July is the coldest month with an average minimum temperature of 8.4°C.

The annual average humidity reading is 75% at 9am and 66% at 3pm. The month with the highest humidity on average is June with a 9am average of 80%, and the lowest is August with a 3pm average of 56%.

Rainfall data from the Newcastle weather station shows that March is the wettest month, with an average rainfall of 119.7mm. The average annual rainfall is 1134.3mm with an average of 99 rain days (PAE Holmes, 2012).

6.6.2.2 Prevailing Winds

Annual and seasonal wind roses were prepared by PAE Holmes (2012) from data collected at the Cooranbong BoM weather station, located 10km southwest of Awaba, for the period January 2009 to December 2009. These are provided in Figure 4.1 of **Appendix L**.

On an annual basis, the most common winds are from the east as well as from the north and south. Winds are recorded from all other directions of the compass but with a lower frequency. During all seasons except winter, the predominant winds are easterly. During summer, the next most common wind direction is southerly, while in spring it is northerly and southerly. During winter, the winds appear to mainly come from the north-western quadrant. The average annual wind speed is 2.8m/s.

To gain an understanding of the wind characteristics at the AWMF site itself, PAE Holmes (2012) undertook modelling using the CALMET software package to generate wind roses for the site.

These differ somewhat from those measured at the Cooranbong BoM weather station, and this can be explained by the strong influence of local topography and land use on wind characteristics at the AWMF site. The CALMET modelling showed that on an annual basis, winds are experienced from all directions. There is a distinct seasonal pattern with summer winds from the northeast through southeast, shifting to dominant west-northwest winds during winter. During Spring and autumn, winds are experienced from all directions. Modelled CALMET wind roses for the AWMF site are provided as Figure 6.1 of **Appendix L**.

6.6.2.3 Odour

It is not always practical to assess the cumulative odour impact of all odour sources that may impact on discrete receptors. However, in a rural area such as Awaba, the number and type of odour sources may be more easily identified. It is common in odour assessment to assess the incremental increase in odour from a proposed development against the assessment criteria, particularly where no other sources of similar odour character are present. No other odour sources are considered to exist in close proximity to the existing AWMF site.

The Awaba landfill has recently received odour complaints, predominantly from local community members in the Awaba township. An existing operations scenario was modelled to assess the potential extent of odour impact from existing operations. Results are presented in **Section 6.6.3.2**.

6.6.2.4 Air Quality

No air quality monitoring stations were available at the AWMF site, however two monitoring stations operated by Eraring Power Station were utilised to provide an indication of air quality in the vicinity of the site. These two stations are located at Dora Creek Bowling Club (approximately 8km south-west of the site) and Marks Point Primary School (approximately 9km south-east of the site).

Table 6.28 presents the NO_2 monitoring data recorded at the Marks Point and Dora Creek monitoring stations between 2000 and 2005. Recorded NO_2 concentrations are of particular relevance to this study and provide an indication of likely background levels in the area. Over the two monitoring sites, the maximum one-hour NO_2 concentrations range from 62µg/m^3 to 141µg/m^3. Over the recording period, all NO_2 concentrations were well below the impact assessment criteria of 246µg/m^3 at both monitoring sites.

Table 6.28: Air Quality Monitoring Data at Dora Creek and Marks Point (PAE Holmes, 2012)

Pollutant (µg/m^3)	Monitoring Year					
	2000	2001	2001	2003	2004	2005
Marks Point						
NO_2 (annual average)	16.9	18.3	13.6	18.3	13.4	12.6
NO_2 (max 1-hour average)	98.0	112.5	90.2	136.2	90.2	88.4
Dora Creek						

Pollutant (µg/m^3)	Monitoring Year					
	2000	2001	2001	2003	2004	2005
NO_2 (annual average)	12.6	12.3	3.3	10.4	16.9	12.8
NO_2 (max 1-hour average)	66.6	75.3	62.0	141.0	95.9	105.3

6.6.3 Potential Impacts

6.6.3.1 Construction Phase

Odour

No construction-related sources of odour have been identified. Odour impacts during the construction phase at the AWMF site are therefore not expected to differ from the existing operational odour emissions at the AWMF site.

Air Quality and Dust

Trucks travelling along unsealed sections of the AWMF site and heavy plant utilised during the construction phase will result in emissions of dust and particulate matter and fugitive dust emissions can also be expected. The same applies to construction machinery working within the road reserves of Wilton, Wangi and Dorrington Roads to trench and install the sewer pipeline. As vegetation will be cleared along the pipeline route to facilitate trenching works, this will temporarily result in exposed soils in the road reserves, which may be susceptible to aeolian (wind) erosion.

PAE Holmes (2012) reported that the potential for adverse dust impacts during the construction phase at the AWMF site is expected to be minimal given separation distances to private residences of 1.5km and the additional screening influence of local topography and vegetation. Dust and particulate modelling was undertaken for the site, and results are provided in **Section 6.6.3.2**.

There are also only a limited number of businesses (the Toronto Country Club and small business park along Dorrington Road), who could potentially be affected by dust due to trenching works for the sewer pipeline, with only a few private residences located in the vicinity of the sewer pipeline route near the Rathmines No. 6 WWPS.

Emissions of CO, NO_x, and sulphur dioxide (SO_2) will occur from diesel-powered construction equipment at the AWMF site and along the sewer pipeline route; however, these are typically too small and too widely dispersed to give rise to significant off-site concentrations.

6.6.3.2 Operational Phase

Odour

PAE Holmes (2012) conducted a series of model runs to assess the potential impacts of the proposed expansions to the AWMF landfill area on air quality and odour at the site.

To account for variations in the location of significant odour-emitting sources over the course of the proposed operational life of AWMF, the existing scenario and two proposed scenarios were modelled:

- **Existing Scenario** includes:
  - An area of intermediate cover across the landfill site;
  - An active tipping face based on existing operations;
  - Daily cover area; and
  - Three leachate ponds to the north and south of the site.
- **Scenario 1** represents an interim stage when the active landfill is occurring towards the north of the site. The following characterises Scenario 1:
  - Stage A is nearly complete (Cells A1 and A2 filled and capped and Cell A3 active);
  - An active tipping face is assigned in the southeast corner of Cell A3;
  - The remaining area of Cell A3 has an intermediate cover;
  - Cells C1 to C4 are capped (from current landfill activities); and
  - Cells B1 to B4 are not yet filled.
- **Scenario 2** represents a worst case scenario where the landfill is approaching end of its life and odour emissions across a maximum footprint are expected. The following characterises Scenario 2:
  - All cells are filled and capped except Cell C4;
  - Cell C4 has the active tipping face in the southeast corner; and
  - The remaining area of Cell C4 has intermediate cover.

Minor odour sources including the waste transfer station and additional re-use centre, wheel wash facility, access road and the pipeline have not been included in the odour modelling.

The existing Scenario and Scenarios 1 and 2 are illustrated in **Figures 6.13, 6.14** and **6.15** respectively.

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Odour Modelling Existing Scenario

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

N
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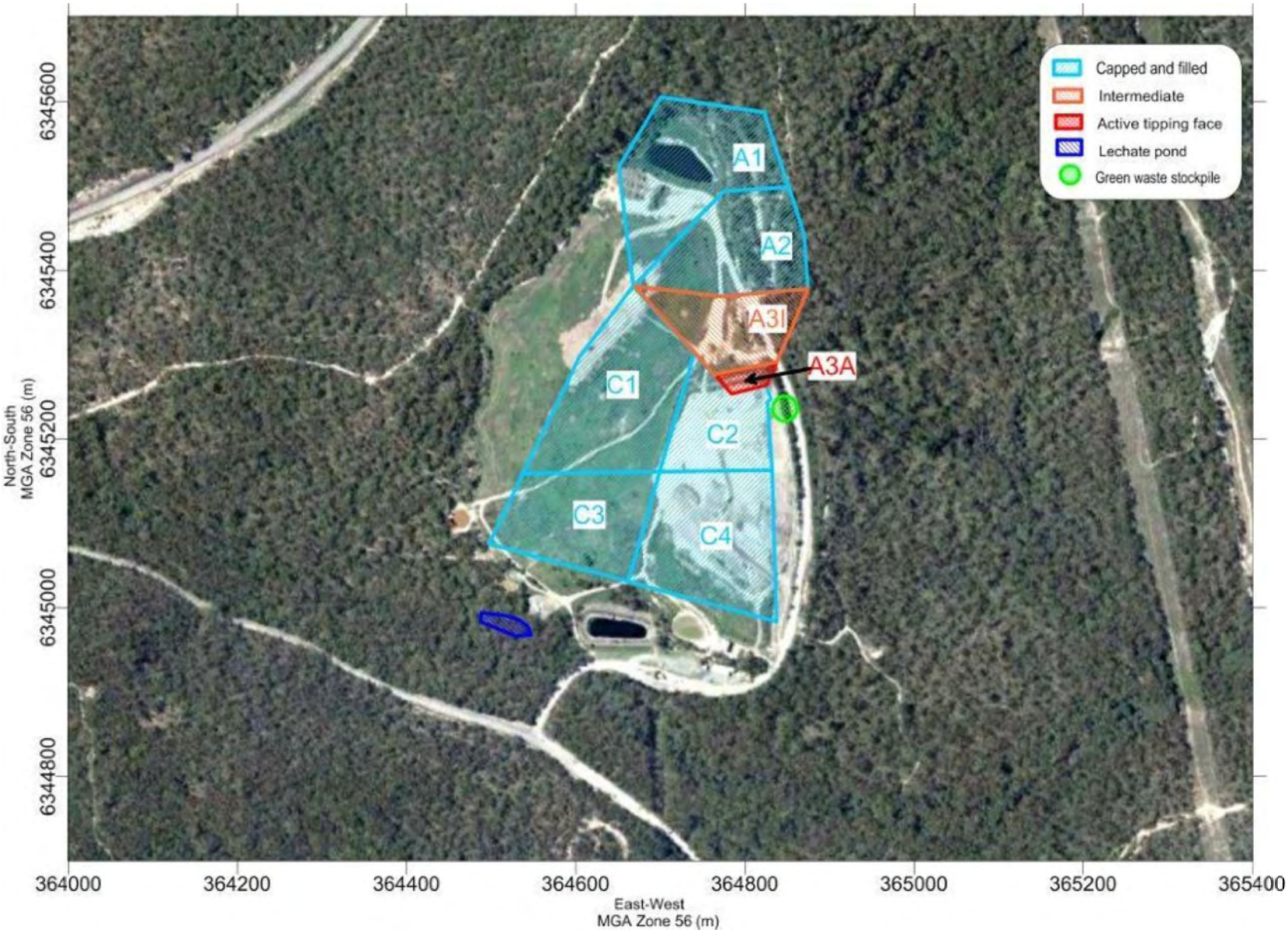
FIGURE 6.13

1:8,000 Scale at A4

Metres
0 25 50 100 150 200

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6013_OdourModellingExistScen.mxd 02



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Odour Modelling Scenario 1

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

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FIGURE 6.14

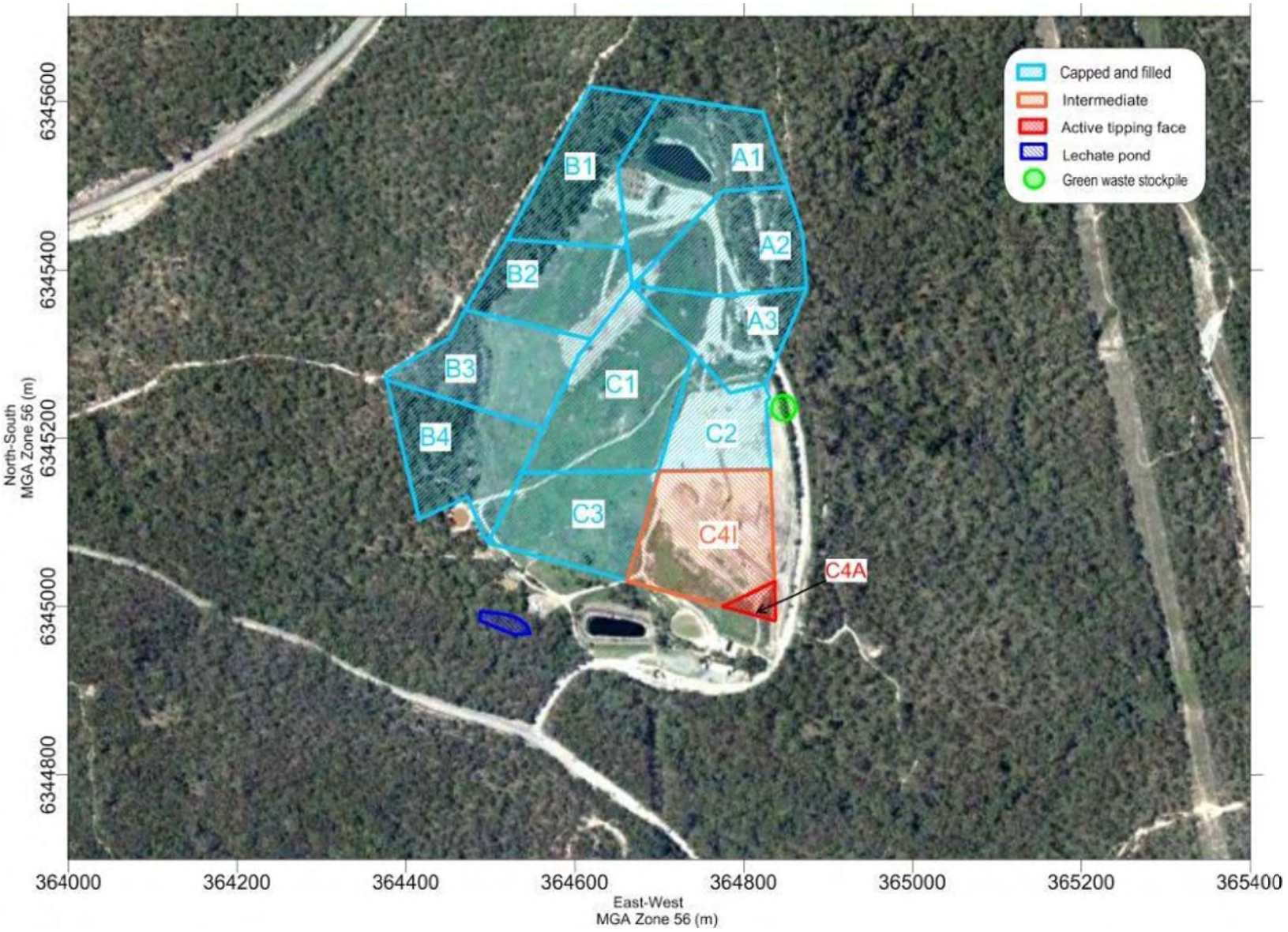
1:8,000 Scale at A4

Metres

0 25 50 100 150 200

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6014_OdourModellingScen1.mxd 02



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Odour Modelling Scenario 2

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

N
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FIGURE 6.15

1:8,000 Scale at A4

Metres

0 25 50 100 150 200

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6015_OdourModellingScen2.mxd 02

On-site odour measurement data was not available for the AWMF. As such, data from odour sampling at a similar site, Eastern Creek Landfill in NSW (PAE Holmes, 2010), has been used to provide an estimate of odour emission rates for the AWMF assessment. Estimates of Specific Odour Emission Rates (SOER) are provided in **Table 6.29**. SOER may be defined as the quantity (mass) of odour emitted per unit time from a unit surface area.

During operation of the landfill, odour emissions can be expected primarily from the active tipping face, with lower emissions from leachate storage ponds and intermediate cover areas. A conservative approach was taken in the assessment of odour and the maximum odour emission rate of 3.65 $OU.m^3/m^2/s$ was applied.

Table 6.29: Estimated Odour Emission Rates for Scenario 1 and Scenario 2

Location/Source	Cells	SOER ($OU.m^3/m^2/s$)
Leachate pond	N/A	0.15
Green waste area	N/A	0.03
Scenario 1		
Filled and capped area	C1-C4 and A1, A2	0.04
Active tip face	A3	3.65
Intermediate cover	A3	0.04
Scenario 2		
Filled and capped area	A1-A3, B1-B4, C1-C3	0.04
Active tip face	C4	3.65
Intermediate cover	C4	0.04

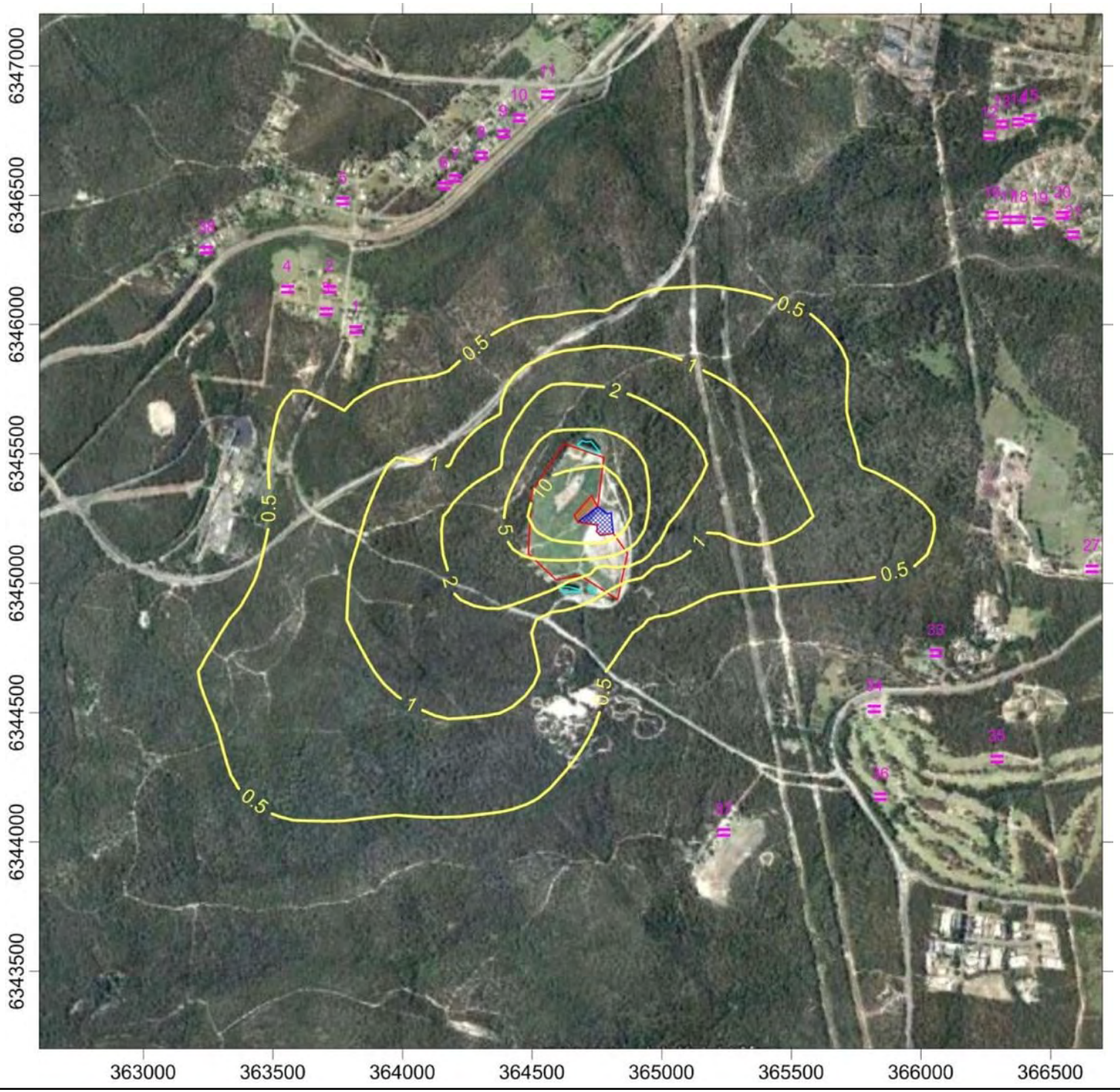
Odour concentration is generally measured by determining the dilution factor required to reach the human "detection threshold" (the dilution at which the sample has a probability of 0.5 of being perceived). The odour concentration at the detection threshold is defined as 1 odour unit (OU). The results of the odour modelling predictions for the Existing Scenario are presented in **Figure 6.16**. Although recent odour complaints have been received, the modelling predictions indicate that beyond 500m from the current active tipping face, odour should not be detected and beyond 250m from the current active tipping face the impact assessment criterion is not exceeded.

Results of the odour modelling for Scenarios 1 and Scenario 2 are presented in **Figure 6.17** and **Figure 6.18**. The contours show the predicted Ground Level Concentration (GLC) of odour at a number of intervals (0.25 OU, 0.5 OU, 1 OU, 2 OU, 5 OU and 10 OU) at the 99th percentile level. Values are expressed as a nose response average (1 second) value.

The contour plots are indicative of the concentrations that could potentially be exceeded 1% of the time, under the conditions modelled.

For both Scenarios 1 and 2, results indicate that the predicted GLC odour at any residential receptor is significantly less than 2 OU, with an average odour concentration of 0.1OU at receptors for Scenario 1 and 0.22 OU for Scenario 2. Odour concentrations are below the detection threshold of 1 OU within 500m of the active tipping face for Scenario 1 and within 900m of the active tipping face for Scenario 2.

Based on visual interpretation of **Figure 6.16**, **6.17** and **6.18**, when compared to the Existing Scenario, Scenario 1 is expected to have a reduced odour impact and odour impacts of Scenario 2 are expected to be similar to existing levels.



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99th Percentile Predicted Odour Levels - Existing Scenario

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Note: Units are in Odour Units

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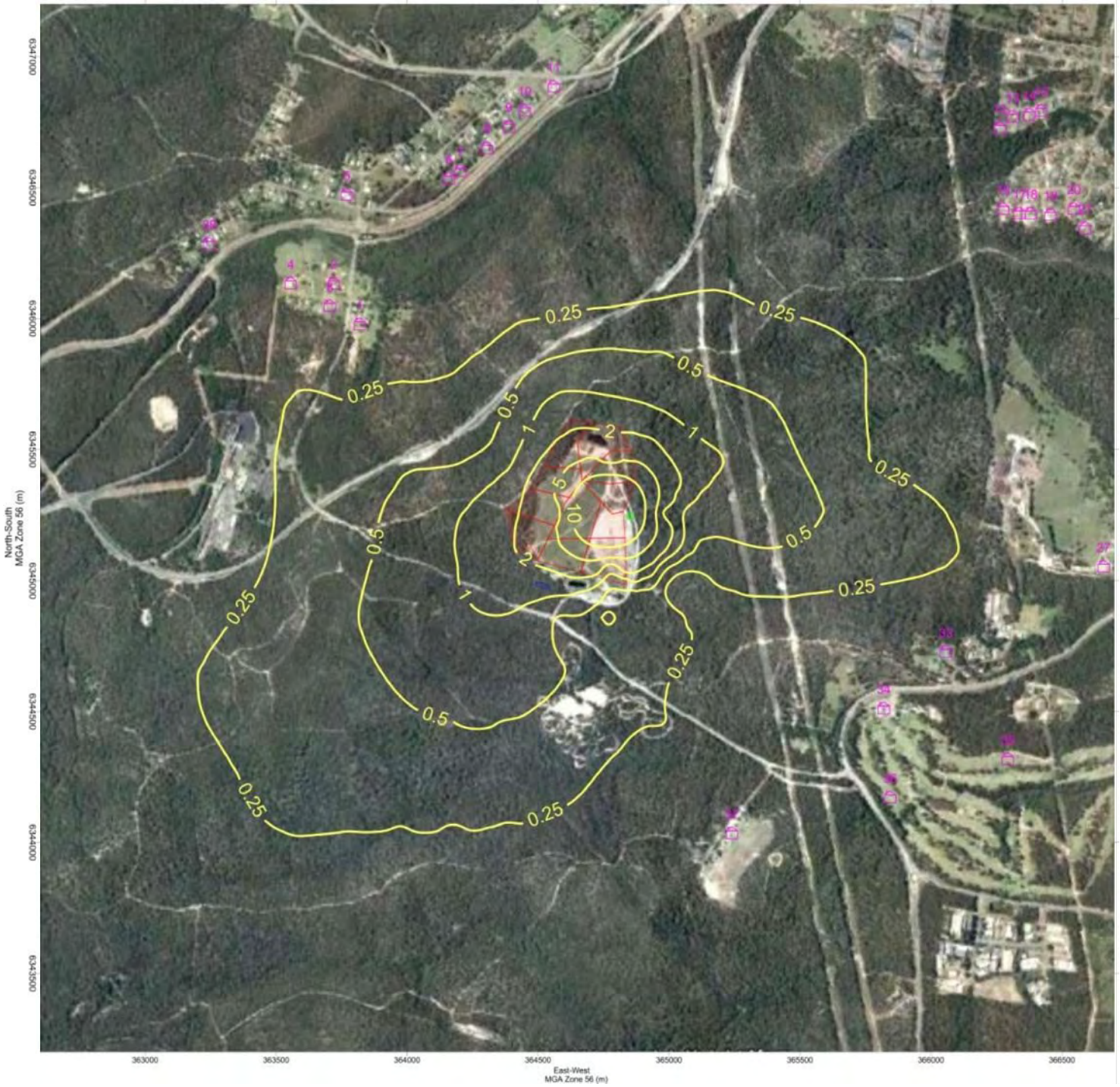
FIGURE 6.16

1:22,000 Scale at A4

Metres
0 50 100 200 300 400 500

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6016_OdourLevelsExistScen.mxd 02



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99th Percentile Predicted Odour Levels - Scenario 1

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Note: Units are in Odour Units

N
W E
S

FIGURE 6.17

1:22,000 Scale at A4

Metres

0 100 200 400 600 800

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6017_OdourLevelsScen1.mxd 02

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99th Percentile Predicted Odour Levels - Scenario 2

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Note: Units are in Odour Units

N
W E
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FIGURE 6.18

1:22,000 Scale at A4

Metres

0 100 200 400 600 800

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6018_OdourLevelsScen2.mxd 02

Potential odour impacts of off-site leachate disposal during the operational phase could occur if the sewer pipeline were to develop a leak and significant volumes of strong smelling leachate were being emitted into the environment, although this scenario is considered highly unlikely. Potential odour impacts could occur at the Rathmines No. 6 WWPS if a leak or spill were to occur during processing of received waste waters, although again this is considered unlikely and would be managed in accordance with current HWC protocols.

Air Quality

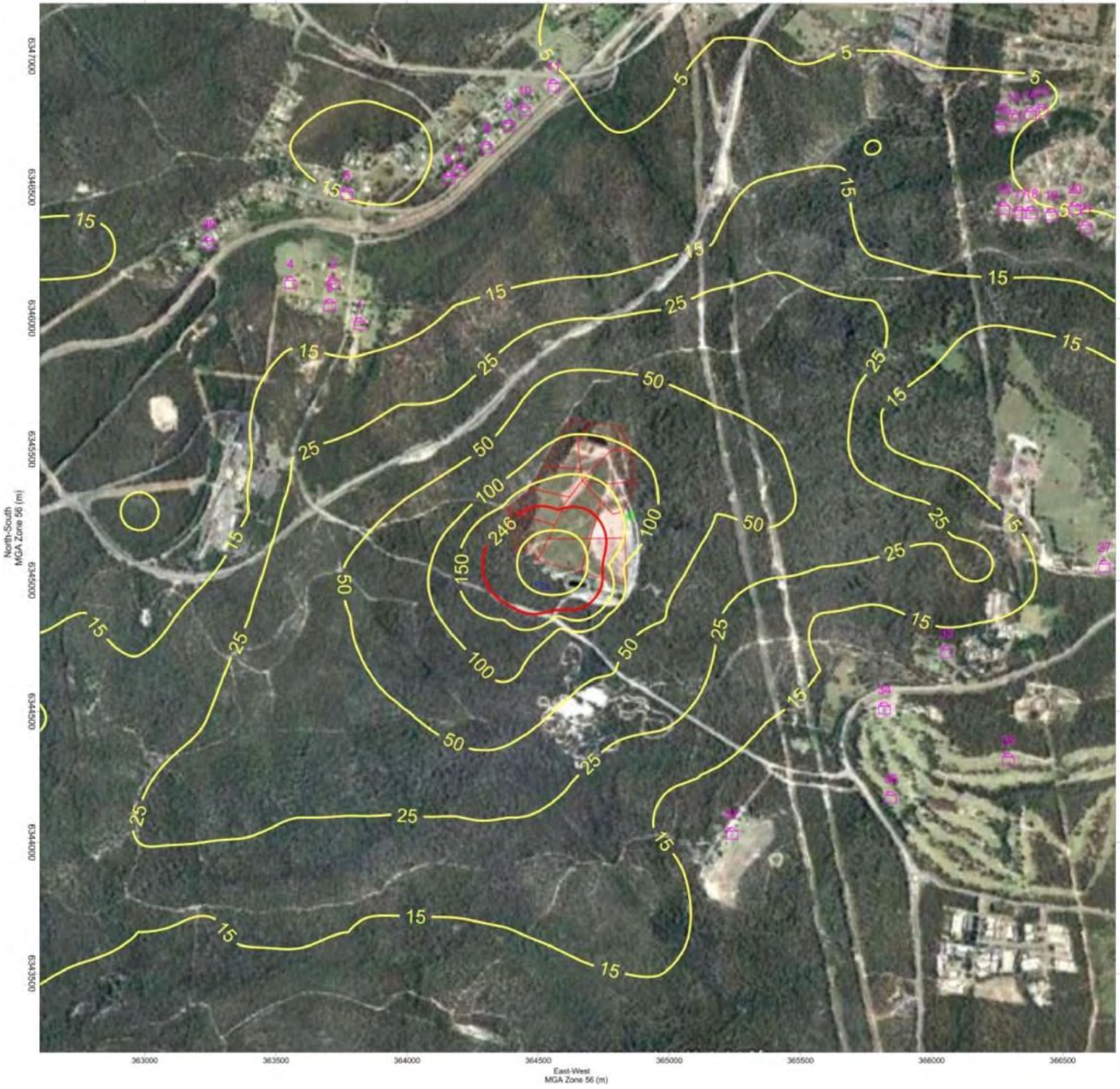
A renewable energy facility is operated at the AWMF site by LMS Generation Pty Ltd (LMS). The facility consists of a 1 MW power generation unit and a backup flare for excess landfill gas destruction. The key pollutant released from power generation and flaring of excess landfill gas will be oxides of nitrogen (NO_x). NO_x is comprised of nitric oxide (NO) and nitrogen dioxide (NO_2). Ultimately, all nitric oxides emitted into the atmosphere are oxidised to NO_2 and to other higher oxides of nitrogen. NO is not considered harmful to human health and generally not considered an air pollutant at the concentrations that are typically found in ambient environments. However, NO_2 is considered harmful, with effects including respiratory infections, asthma and chronic lung disease.

Monthly reports on landfill gas are prepared by LMS, and based on these reports PAE Holmes (2012) estimated the emissions for a worst case scenario which assumes that flaring and power generation occur at the same time. The estimated NO_x emission rates were 0.04g/s for the flare stack and 2.716g/s for the gas power generation. Modelling of emissions from the operation of the flares and power generation facility was conducted based on these emission rates.

In the assessment it was assumed (conservatively) that the ratio of NO_2 to NO_x is 20% by the time that the plume has reached the point where the maximum Ground Level Concentrations (GLC) are predicted.

The rate of conversion of NO_x to NO_2 can vary from a few minutes to many hours and depends on a range of prevailing atmospheric conditions. Based on the average wind speed for the hour of maximum GLC, it is estimated that it would take less than 1 minute for the plume to reach nearby locations, and as such, significant oxidation would not have occurred in this short time frame. Alternatively, at residence locations over 1 km away, the plume would take longer to reach these areas (23 minutes for the worst case prediction) and as such, dispersion would be sufficient to have diluted the plume substantially such that oxidation rates are no longer important.

Predicted 1-hour NO_2 concentrations for the flaring and power generation for the proposed extension of operations are presented in **Figure 6.19**. The NSW OEH prescribes ambient impact assessment criteria for NO_2, as 0.12ppm for the one hour averaging period, and 0.03ppm for the annual averaging period. Based on this, an assessment criterion for air quality impacts at the site was set at 246µg/m^3. In **Figure 6.19**, contour values are in µg/m^3, and the assessment criteria of 246µg/m^3 is shown in red.



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Predicted 1-Hour NO_2 Concentrations for Operation of Renewable Energy Facility

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- Assessment Criteria of 246 µg/m³
- Predicted Ground Level Concentration (µg/m³)

Note: Worst case scenario with flare and power generation units operating simultaneously.

®

FIGURE 6.19

1:22,000 Scale at A4

Metres

0 100 200 400 600 800

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd
Date: 2012-07-06
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6019_PredictedNO2Conc.mxd 02
Imagery supplied by LMCC and associated third party suppliers

The maximum predicted 1-hour NO_2 concentration at the closest residences is 12.5µg/m^3, which is well below the assessment criteria of 246µg/m^3. All annual average predictions are less than 1µg/m^3. Model results therefore indicate that NO_2 concentrations are unlikely to be substantial in the areas surrounding the AWMF site in the operational phase.

Aside from NO_2, combustion emissions, including carbon monoxide (CO) and Volatile Organic Compounds (VOCs) from power generation and flaring will occur onsite; however, these are anticipated to be much less dominant than NO_2, and are not anticipated to cause emissions issues in the vicinity of the site. Trucks and heavy plant at the active face will result in emissions of particulate matter, whilst emissions of CO, NO_x, and sulphur dioxide (SO_2) will occur from diesel-powered equipment being utilised at the tip face; however, these are typically too small and too widely dispersed to give rise to significant off-site concentrations.

No air quality impacts due to the sewer pipeline or the ancillary proposed facilities at the AWMF site (waste transfer station, additional reuse centre, wheel wash facility, etc.) are anticipated during the operational phase.

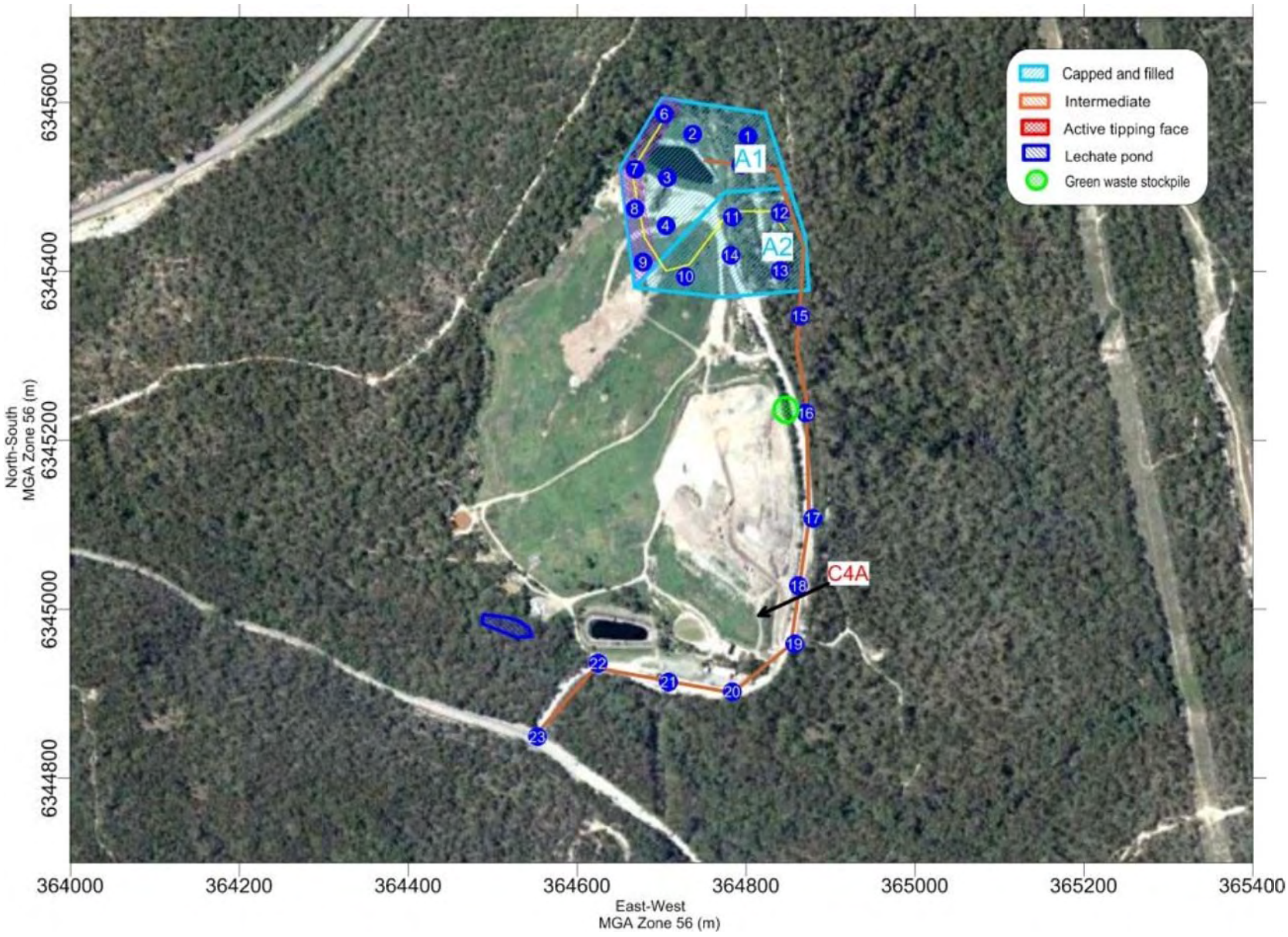
Dust and Particulate Matter

During operation of the site, dust emissions can be expected from trucks travelling on unsealed sections of the AWMF site delivering waste, unloading waste, plant and equipment involved in capping and filling and wind erosion from exposed ground. Emissions from vegetation clearance, topsoil stripping and excavation can also occur at the AWMF site, particularly during dry and windy conditions. No long term dust impacts should be associated with the sewer pipeline as it will be re-vegetated at the completion of installation.

A scenario was modelled to represent the construction of the landfill cells and the ongoing operation of landfilling within previously constructed cells. Excavation in cell A2 was chosen as representative of worst-case scenario based on the volume of material estimated for removal. The following activities have been represented for this scenario:

- Construction Activity: Excavation in cell A2, loading material to trucks, hauling to a stockpile area in cell A1 and unloading from trucks;
- Landfill Operations: Trucks delivering waste to site travelling on unsealed roads to landfill cell A1. Cover material loading to trucks, hauling to cell A1 and unloading. Dozers spreading daily cover for cell A1.

Water spraying has been assumed as a control, applied to haul roads and active exposed areas during construction and operation. A visual presentation of this modelling scenario is shown in **Figure 6.20**. Dust source locations are represented by the numbered dots, and represent all activities described above.



Lake Macquarie City Council

Construction and Operational Dust Modelling Scenario

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

N
W
E
S

FIGURE 6.20

1:8,000 Scale at A4

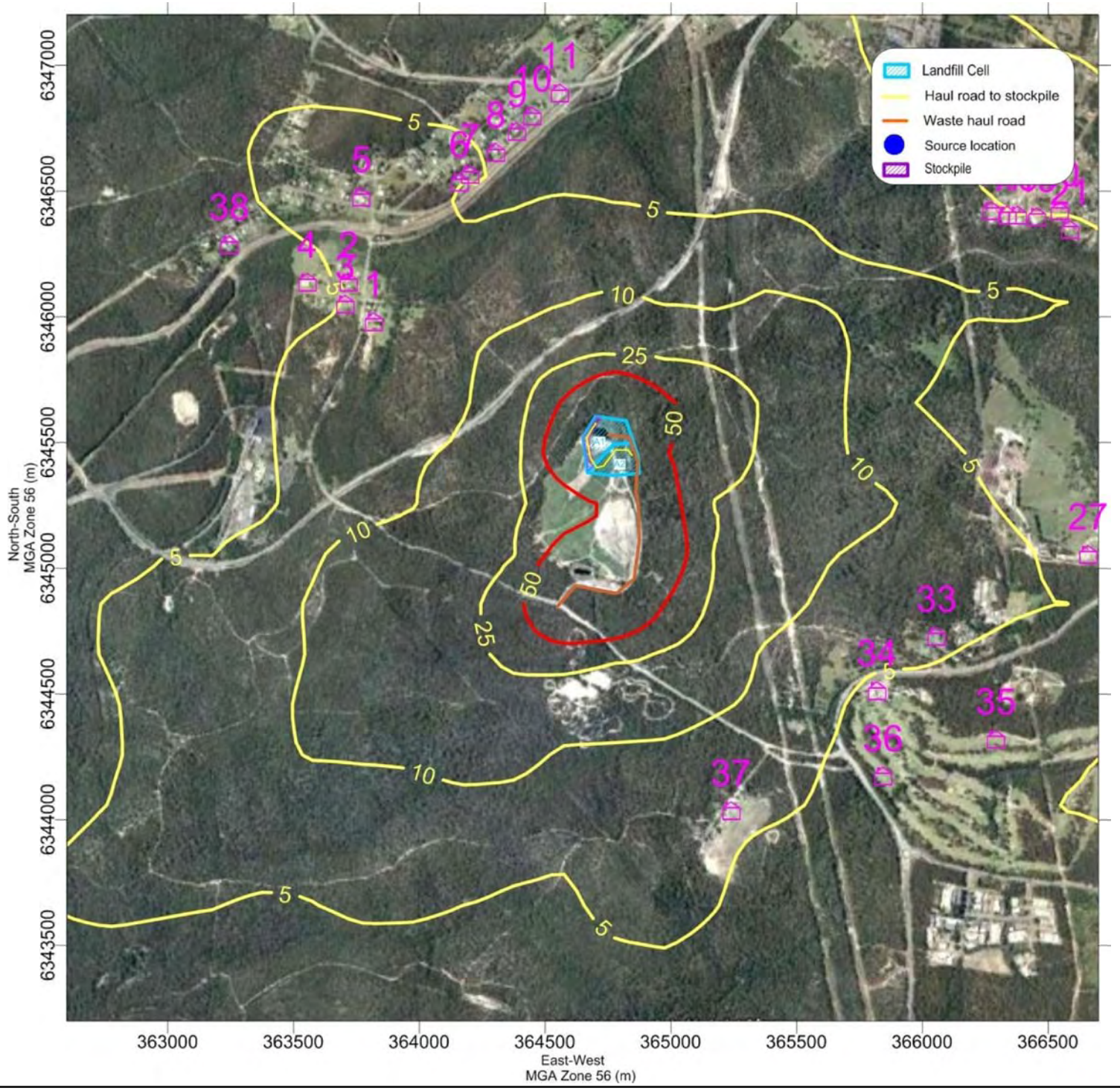
Metres
0 25 50 100 150 200 250

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6020_DustScen.mxd 02

The results of the dust modelling predictions (24-Hr PM_{10}, annual PM_{10} and annual deposition) for the construction and operational scenario are presented in **Figure 6.21**, **Figure 6.22** and **Figure 6.23**. The OEH criterion for each dust pollutant is shown with the red line.

The maximum predicted 24-hour PM_{10} concentration at a residence is 7.1 $\mu g/m^3$ which is well below the assessment criteria of 50 $\mu g/m^3$. All annual average predictions are well below 1 $\mu g/m^3$. Dust deposition levels are predicted to be minor beyond 50 m to 100 m of the site.



Lake Macquarie City Council

Predicted 24-Hour PM_{10} Concentrations for Construction & Operation

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- OEH Criteria of 50 µg/m³
- Predicted Ground Level Concentration (µg/m³)
- Modelled Receivers

N
W E
S

FIGURE 6.21

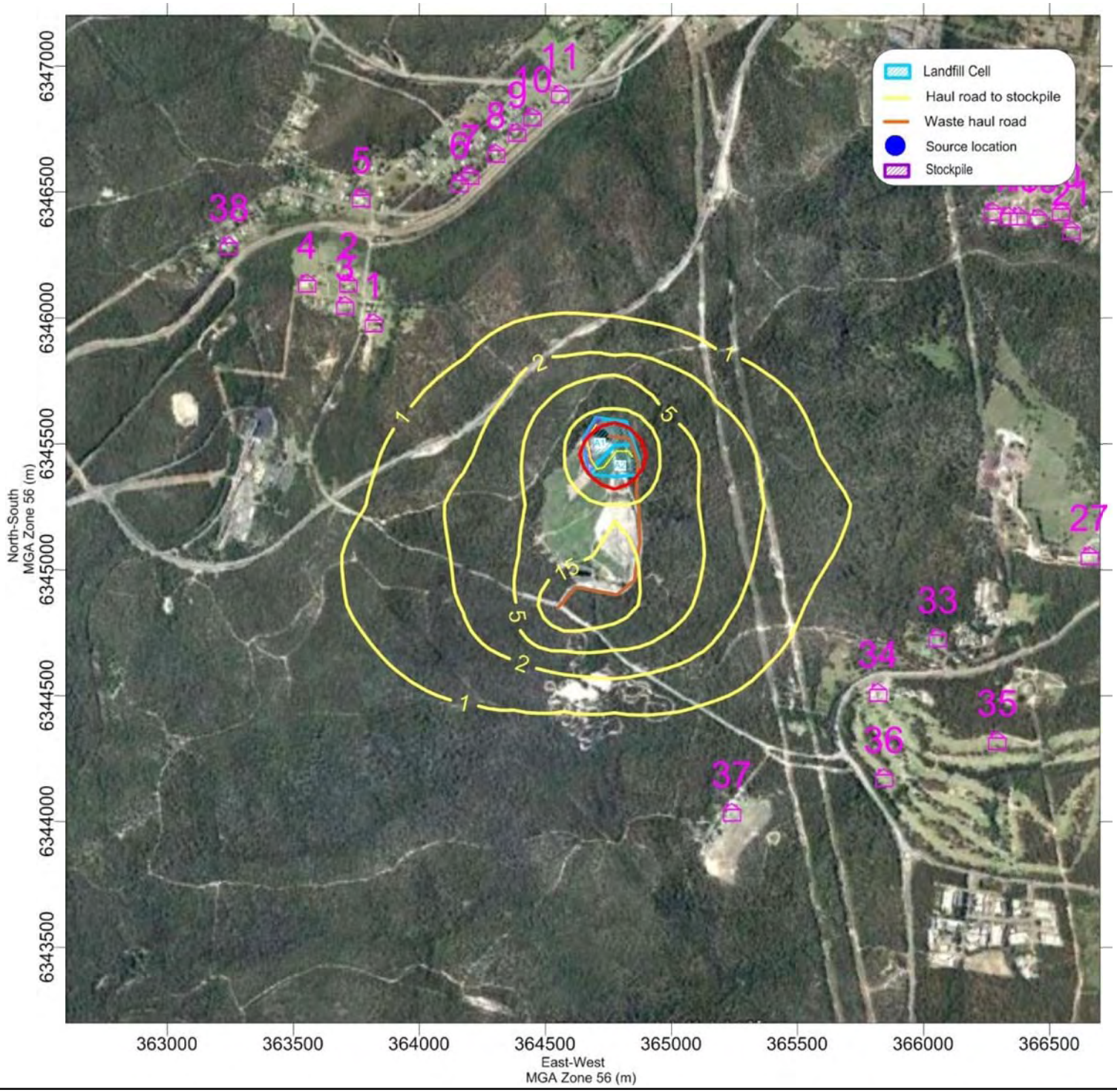
1:22,000 Scale at A4

Metres

0 100 200 400 600 800

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6021_24hrPM10DustLevels.mxd 02



Lake Macquarie City Council

Predicted Annual PM_{10} Concentrations for Construction & Operation

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- OEH Criteria of 30µg/m
- Predictied Ground Level Concentrations (µg/m)
- Modelled Receivers

N
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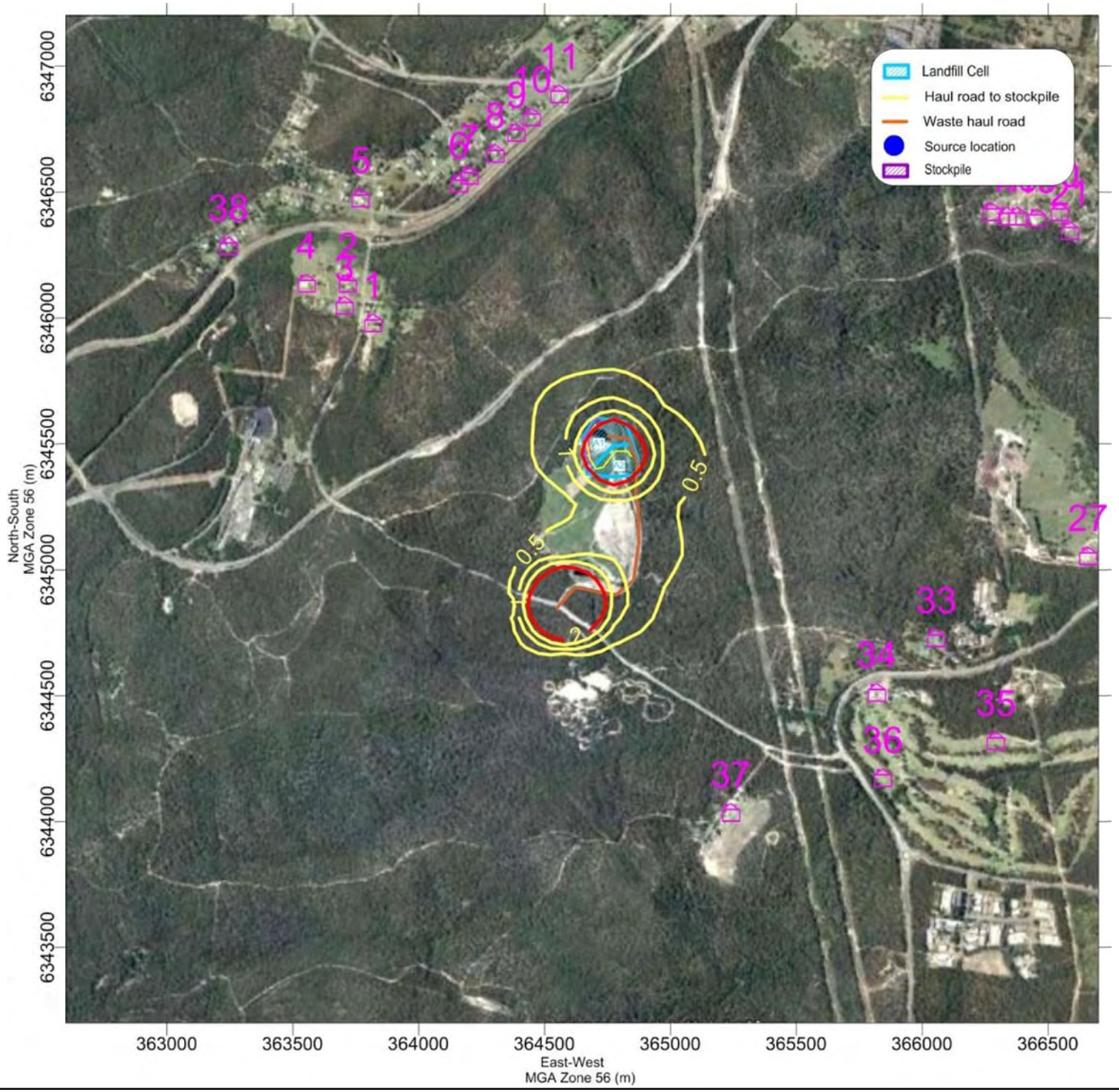
FIGURE 6.22

1:22,000 Scale at A4

Metres
0 100 200 400 600 800

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6022_AnnualPM10DustLevels.mxd 02



Lake Macquarie City Council

Predicted Annual Dust Deposition Concentrations for Operation

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- Predicted Annual Dust Deposition Concentration (g/m²/month)
- OEH Criteria of 2 g/m²/month
- Modelled Receivers

N
W E
S

FIGURE 6.23

1:22,000 Scale at A4

Metres
0 100 200 400 600 800

Cardno

Data Source: PAE Holmes (2012)
Map Produced by Cardno NSW/ACT Pty Ltd
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6023_AnnualDustDeposLevels.mxd 02

Cumulative Impacts

If the proposed additions are approved, LMCC would obtain a new EPL for future site operations, commence proposed excavation in stages (starting with Area A) and then cease existing operations and apply interim capping at the existing active tipping face. Filling of the existing active tipping face and filling of future excavation areas would not occur simultaneously (i.e. existing and proposed operations would not occur simultaneously) and as such, no cumulative impacts are anticipated in this regard.

The air quality data provided in **Table** 6.28 (Dora Creek and Marks Point stations), shows a maximum 1-hour NO_2 concentration of 141µg/m^3 across the two stations, and this can be taken to represent a maximum "background" concentration of NO_2 in the area. Addition of this maximal background concentration (141µg/m^3) to the predicted maximum 1-hour concentration from the air quality modelling (12.5µg/m^3), results in a concentration of 153.5µg/m^3. This estimate provides a conservative indication of cumulative impacts at the site. Joint occurrence of these two maximums would be unlikely to occur, but if they did, the resulting concentration (153.5µg/m^3) is below the assessment criteria of 246µg/m^3. In terms of annual averages, the addition of NO_2 concentrations of less than 1µg/m^3 would not result in cumulative annual average impacts.

With regards to dust and particulates, recent PM10 monitoring data recorded at Wallsend shows a maximum 24-hour concentration of 38.9 µg/m3. The highly conservative approach of adding a maximum background to the maximum predicted 24-hour concentration gives a cumulative concentration of 46 µg/m3 which is below the criteria of 50 µg/m3. The addition of annual average concentrations of less than 1 µg/m3 would not result in cumulative annual average impacts.

6.6.4 Mitigation Measures

6.6.4.1 Construction Phase

Air quality and dust impacts at the AWMF site and along the sewer pipeline route can largely be controlled through good site environmental practice and commonly applied dust management measures. Prior to commencement of works a CEMP would be developed which would include air quality and dust management / mitigation procedures, such as those specified by PAE Holmes (2012), including:

- Procedures for controlling / managing dust;
- Roles, responsibilities and reporting requirements;
- An outline of the dust control inspection regime; and
- Potential contingency measures for dust control where standard measures are deemed ineffective.

The following dust mitigation measures should be considered as part of the CEMP:

- All vehicles on site should be confined to a designated route with a speed limit enforced;
- Number of trips and trip distances should be controlled and reduced where possible;
- Delivery and removal of materials should be planned and coordinated to avoid unnecessary trips;
- Dirt that has been tracked onto sealed roads should be cleaned as soon as practicable;
- Spoil trucks should be covered when the load is dry and tailgates should be effectively sealed prior to leaving the site;
- When conditions are excessively dusty and windy a water truck (for water spraying of haulage routes) should be used;
- Use of a water cart to dampen surfaces prior to grading / scraping;
- Modify working practices by limiting vegetation clearance, topsoil stripping and excavation during periods of high winds;
- Limiting the clearing of vegetation and topsoil to the designated footprint required for construction;
- Avoid unnecessary vegetation clearing so that wind erosion from exposed ground is minimised; and
- Minimise the number of stockpiles on site and the number of work faces on stockpiles.

Wind erosion from exposed ground should be limited by avoiding unnecessary vegetation clearing both at the AWMF site and along the sewer pipeline route. Wind erosion from temporary stockpiles can be limited by minimising the number of stockpiles on site and minimising the number of work faces on stockpiles. As material is removed or added to stockpiles, the area should be compacted to promote particle cohesion.

6.6.4.2 Operational Phase

Odour

The odour emissions from the proposed additions to AWMF were found to be within acceptable levels at the nearest residential receivers, and as such, mitigation measures are minimal. However, standard management practices for landfill sites would be utilised, including the following:

- Sub-surface gas monitoring program;
- Surface gas emission monitoring program; and
- Covering/capping of waste.

These would assist in maintaining appropriate odour levels. In addition, an odour complaints register would be set up and maintained. Any complaints would be dealt with in an appropriate manner such that a corrective action is taken whenever a complaint is received.

Air Quality

The modelled emissions of NO_2 and other substances from the proposed additions to the AWMF were found to be within acceptable levels at the nearest residential receivers, and as such, extensive mitigation measures are not required. However, standard management practices for landfill sites would be employed including:

- Maintenance of the gas collection infrastructure, power generation unit and flare stack;
- Flare stack emission monitoring program; and
- Maintaining plant and equipment on site so that they are functioning optimally.

Dust

Operational impacts from dust will largely be controlled through good site environmental practice and commonly applied dust management measures. Staging of the expanded landfill (staged vegetation clearing, excavation, lining and landfilling followed by capping) will help to reduce the amount of exposed ground at any one time. Many of the mitigation measures described in **Section 6.6.4.1** for the construction phase can also be applied during the operation of the landfill, including dust suppression techniques such as spraying with a water cart and stockpile management, in accordance with best management practice for a landfill site.

Eventual capping and re-vegetation of the entire AWMF landfill site once landfilling operations are complete (estimated to be December 2032) will minimise potential dust impacts from the site into the future.

6.7 Aboriginal Heritage

The proposed extensions to the AWMF have the potential to cause damage to, or reduce the heritage significance of, artefacts of Aboriginal cultural significance due to displacement, burial or destruction. The pipeline route is likely to have a more limited impact on the wider Aboriginal cultural landscape of the region.

Four unregistered artefacts were identified within the AWMF site, and two along the pipeline route. In addition, an area of potential archaeological sensitivity was identified at the south-western portion of the AWMF site and along the creeklines. Sub-surface testing in this area will be undertaken to identify and appropriately manage any additional artefacts.

6.7.1 Introduction

The sections below examine the existing environment in the context of Aboriginal heritage and historical use and consider the potential impacts of the construction and operation phases of the proposed additions to the AWMF on Aboriginal cultural heritage items and places. Mitigation measures to reduce impacts on Aboriginal heritage have also been recommended.

Insight Heritage (2011) conducted an Aboriginal Cultural Heritage Impact Assessment for the expansion works on the AWMF site (not including the proposed sewer pipeline route) and the assessment findings have been incorporated into this section. The full assessment document is provided as **Appendix M**.

Niche (2011) conducted a subsequent assessment for the proposed sewer pipeline route and the assessment findings have also been incorporated into this section. The full assessment document is provided as **Appendix N**.

Both assessments have involved substantial input from various registered Aboriginal parties, and details of this can be found in the **Appendices M** and **N**.

6.7.2 Existing Environment

The project area is located within the country of the Awabakal, whose territory extended from the southern reaches of Lake Macquarie to the Sugarloaf Ranges in the west and the Hunter River in the north.

The culture and life of Aboriginal peoples in the Lake Macquarie area was documented in the early 1800s by L.E. Threlkeld and included observations and reports on Awabakal language, clan territories, kinship and mythology. Excerpts are provided by Insight Heritage (2011).

Lake Macquarie and associated watercourses such as Stockyard Creek are known to have provided a varied and rich range of resources; including shellfish, fish, bird, mammal, reptile and amphibians. Hence it was anticipated that middens may be present within the overall assessment area and may provide evidence of exploitation of faunal resources (Niche, 2011).

An appreciation of the Aboriginal archaeological context of the AWMF site was achieved through examination of previously recorded archaeological deposits and artefacts, an Aboriginal Heritage Information Management System (AHIMS) search, and through a site survey and sub-surface testing by Insight Heritage (2011). Similarly an appreciation of the Aboriginal archaeological context of the sewer pipeline route was achieved through a subsequent AHIMS search and a site survey of the pipeline route by Niche (2011). The findings from both these heritage assessments are discussed below.

6.7.2.1 Previously Recorded Artefacts

A number of artefacts have been previously recorded in the local area surrounding the AWMF site. These provide an indication of the broader Aboriginal archaeological context of the Lake Macquarie LGA. Details of the recorded artefacts are provided in Insight Heritage (2011) and Niche (2011).

6.7.2.2 AHIMS Search – AWMF Site and Surrounds

The AHIMS database is maintained by the OEH. An online search of this database was conducted by Insight Heritage (2011) to ascertain if any previously recorded archaeological sites occur within the study area so as to assess if these sites may be negatively impacted by the proposed development, with results shown in **Table 6.30**.

Table 6.30: AHIMS Database Search Results

Database Search	Description	Count
Lot 372 DP723259 with a 50m buffer	No previously recorded artefacts	0
5km area around Lot 372 DP723259 (encompassing Easting 362,000 to 367,000 and Northing 6,343,000 to 6,348,000)	Artefact scatter / open camp site	2
	Potential archaeological deposit (PAD)	1
	Artefact, grinding groove, shelter with deposit	1
	Grinding groove	1
	Grinding groove with waterhole	1

6.7.2.3 AHIMS Search – Sewer Pipeline Route

Similarly, an online search of the AHIMS database was conducted by Niche (2011) on 3 November 2011 centred on the sewer pipeline route. The search identified 79 currently recorded Aboriginal sites in the general locality of the pipeline; however, no previously identified Aboriginal sites were recorded within the impact area of the pipeline.

Two midden sites (45-7-0246 and 45-7-0247) are noted to occur in close proximity (40m west) of the proposed pipeline route near the access road to the Rathmines No. 6 WWPS.

6.7.2.4 AWMF Site Survey

A site survey of the AWMF was undertaken on 7 April 2011 by Insight Heritage and attended by several representatives from most of the registered Aboriginal parties including Awabakal Local Aboriginal Land Council (ALALC), Awabakal Descendants Traditional Owners Aboriginal Corporation (ADTOAC) and Awabakal Traditional Owners Aboriginal Corporation (ATOAC). The purpose of the survey was to:

- Identify any Aboriginal objects or sites that may be impacted by the proposed works, including any areas with the potential for sub-surface archaeological deposits (areas of PAD) or areas of archaeological sensitivity; and
- Identify the requirement for any further works and development of appropriate management strategies in partnership with the registered Aboriginal parties prior to development.

The AWMF project area was divided into five survey areas based on landform. The survey was conducted on foot across each survey area, with transects being approximately 60m wide, and with each participant approximately 10m apart (depending on vegetation). Straight lineal survey transects could not be undertaken due to vegetation constraints.

Where present, dirt access tracks were utilised for access through the study area (these often provided the only opportunity for visibility). Within each survey area, members of the field team also inspected features of interest, e.g. rocky outcrops, areas of exposure, or large trees (for potential scars).

The site survey revealed three findings/sites, all modified trees. A description of the three survey site findings is provided in **Table 6.31**. Further details on the survey methodology are provided in **Appendix M**.

Table 6.31: AWMF Site Aboriginal Heritage Survey Findings (Insight Heritage, 2011)

Survey Artefacts	Dimensions (cm)					Description
	Length	Max. Width	Re-growth Thickness	Trunk Girth	Base of Scar to Ground Level	
AWTF_ST1	116	18	11	210	75	Scar on south face of Mahogany or Stringybark.
AWTF_ST2	171	43	9	302	116	Scar on south east face of tree. Tree is dead and has also been burnt, so difficult to identify species. Scar on south-east side of tree.
AWTF_ST3	78	42	5	237	110	Scar located on north-western side of tree, also fire damaged scar at base of tree on the opposite side.

The assessments undertaken by the registered Aboriginal parties for the project did not identify any Aboriginal places within the project area.

6.7.2.5 Sewer Pipeline Site Survey

Similarly, a site survey of the sewer pipeline route was undertaken on 4 November 2011 by Niche and attended by a representative from most of the registered Aboriginal parties including ADTOAC, ATOAC and Cacatua Culture Consultants (CCC).

The site survey identified two previously unregistered Aboriginal sites within the pipeline impact area. A description of the two survey site findings is provided in **Table 6.32**. Details on the survey methodology are provided in **Appendix N**.

Table 6.32: Sewer Pipeline Route Aboriginal Heritage Survey Findings (Niche, 2011)

Survey Artefacts	Easting / Northing Location	Visibility	Description
AWMF Pipeline Isolated Find 1	366291 / 6343775	High	A medial tertiary broken silcrete flake, approximately 2cm in length, located on a spoil heap spoil heap created from road construction on Dorrington Road.
AWMF Pipeline Midden 1	364901 / 6344577	High	A midden, consisting of approximately 50 fragments of shell, identified on an exposed track immediately north of Wilton Road. The shells were primarily fresh water mussels and cockle. The visible area was recorded as 4.5m x 1m. The southern-most extent of the site was in the survey area and it extended north out of the survey area. Shell was eroding from the exposure suggesting sub-surface deposit. There is a high probability that this site extends beyond these measurements and into areas of 0% surface visibility.

The survey also identified areas of low visibility but potential archaeological sensitivity near creek lines.

The registered Aboriginal parties who participated in the survey also noted any unregistered sites or culturally sensitive areas they were aware of in close proximity to the assessment area. These areas were mapped and are presented in Figure 4 of the Aboriginal Cultural Heritage Assessment report by Niche (2011) in **Appendix N**.

6.7.2.6 Sub-Surface Testing

A site survey to undertake sub-surface testing at the AWMF site was undertaken on 8 April 2011 by Insight Heritage and was again attended by several representatives from ALALC, ADTOAC and ATOAC.

Test probes were placed in the areas of the proposed leachate basins. These were located within 200m of an unnamed tributary which flows east into Lake Macquarie. The purpose of the test probes was to:

- Test soil depth and the boundary of sensitivity from the creek line; and
- Define any areas of sensitivity or areas of potential archaeological deposit which may require further assessment prior to impacts if the proposed development is approved.

Sub-surface testing occurred along a north-south transect for a distance of approximately 150m, from the edge of the 30m buffer on the northern side of the creek line and upslope through the proposed leachate basins. Test probes of 50cm x 50cm were excavated at intervals of 10-15m along the transect. The area of the northern-most proposed leachate basin was highly disturbed from the construction of the existing sediment pond, and so test probes were not placed in this area. Excavated material was dry sieved using a 5mm wire aperture hand sieve.

A total of seven test probes were used, with an area of 1.75m² excavated in total. Soil profile disturbances were noted in test probes 1-5, with test probes 6 and 7 being the least disturbed. Test probe 7 revealed an artefact, a silcrete broken flake which was recovered at approximately 250mm depth. This was the only artefact to be uncovered from the sub-surface testing. The artefact was uncovered at a gentle bench adjacent to the creek-line, and this indicates that further artefacts are likely to be located in this area. The artefact was reburied in the north-west corner of test probe 7, with a labelled survey stake placed at the location of reburial.

6.7.2.7 Values and Significance – AWMF Site

The findings of the site survey and sub-surface testing were assessed for scientific values and significance by Insight Heritage (2011) and **Table 6.33** presents the findings.

Table 6.33: AWMF Site Artefacts Significance Assessment (Insight Heritage, 2011)

Significance Type	Criterion	Assessment Findings
Scientific	Assessment within a local and regional context to enable a merit-based approach that compares the site with other sites of similar nature within similar contexts.	The three identified cultural modified trees are assessed as being of moderate scientific significance. The silcrete flake recovered from test probe 7 is assessed as being of low significance though it may be associated with other artefacts which could potentially increase the significance rating.
Public	Assessment of the site in terms of educational value and potential to enhance community knowledge and appreciation of cultural heritage.	The three identified cultural modified trees are assessed as being of moderate public significance.
Cultural	Assessment of the site by registered Aboriginal parties. Cultural significance can only be determined by Aboriginal people. Generally, all sites are of significance to Aboriginal people.	In general all of the sites identified by the assessment are of cultural significance to the registered Aboriginal parties, as they represent a tangible link with the past land use practices of their Awabakal ancestors. Particular significance is associated with the possible culturally modified trees. Cultural significance is also apparent for the area of identified archaeological sensitivity adjacent to the creek line as it has the potential to contain sub-surface Aboriginal objects.
Representative	Assessment of a site based on factors such as representativeness, rarity, and potential to add scientific data to what is known about past	The three identified cultural modified trees are assessed as being of moderate representative significance.

Significance Type	Criterion	Assessment Findings
	human occupation of the Australian continent.	

6.7.2.8 Values and Significance – Sewer Pipeline Route

Niche (2011) undertook an assessment of archaeological significance for the two Aboriginal archaeological sites identified during the pipeline survey and **Table 6.34** presents the findings.

Table 6.34: Sewer Pipeline Site Artefacts Significance Assessment (Niche, 2011)

Survey Artefacts	Assessment Findings	Archaeological Significance
AWMF Pipeline Isolated Find 1	The presence of the Aboriginal Object indicates that other Aboriginal Objects may be present at low densities within the impact footprint but will be highly disturbed from road construction works. The artefact has limited ability to provide a chronology or help connect activities to other sites in the archaeological landscape. Silcrete artefacts are one of the most common Aboriginal Objects in the region and there are multiple examples of this class of Aboriginal Object being conserved in the region.	Low archaeological significance.
AWMF Pipeline Midden 1	The southern visible extent of the site occurs within the impact footprint. The exact nature and extent of the site is unknown. The presence of shell eroding from the exposure indicates that other sub-surface Aboriginal Objects may be present both within and beyond the impact footprint area and so the area surrounding the identified midden is considered to be a Potential Archaeological Deposit (PAD). It is likely that the midden within the impact footprint has been disturbed by past road construction works; however, outside this area the midden may be in reasonable condition. The site has research potential as it may provide information regarding exploitation of food resources in the area but is unlikely to provide chronological information in the impact footprint due to past disturbance from road construction. Middens are not uncommon in the region and there are several examples of this class of Aboriginal site being conserved in the region.	Within the pipeline impact footprint the midden site is considered to have moderate archaeological significance due to past disturbances. However, outside the impact footprint the site is considered to have high archaeological significance for its ability to provide potentially in-situ information regarding past resource use.

6.7.3 Potential Impacts

6.7.3.1 AWMF Site

The proposed extensions to AWMF have the potential to cause damage to, or reduce the heritage significance of artefacts of Aboriginal cultural significance, due to displacement, burial or destruction. Insight Heritage (2011) found four cultural heritage artefacts in the AWMF study area from the site survey and sub-surface testing, three modified trees and one silcrete broken flake. Of these four artefacts, two are located inside the works footprint of the AWMF expansion works. **Table 6.35** gives an indication of the location of each artefact and the potential impacts.

Table 6.35: Artefacts Significance Assessment (Insight Heritage, 2011)

Survey Artefacts	Type of Artefact	Location	Level of Impact
AWTF_ST1	Modified tree	Outside of the works footprint, immediately to the north of the proposed leachate basin in the southwest of the AWMF site.	Should not be impacted.
AWTF_ST2	Modified tree	Within the works footprint (proposed cell Area B), on the western side of the AWMF site.	Will be impacted.
AWTF_ST3	Modified tree	Outside the works footprint, adjacent to the existing fire trail/access track that runs along the ridgeline on the northwest boundary of the AWMF site.	Should not be impacted.
Test Probe 7	Silcrete broken flake	Within the works footprint, in the vicinity of the southernmost proposed sediment basin.	Will be impacted.

In addition to the above artefacts, Insight Heritage (2011) identified an area of potential archaeological sensitivity at the south-western portion of the site, on the northern side of the creek line. The location of the southernmost proposed leachate basin coincides with the location of this sensitive area. Negative impacts on this sensitive area are therefore likely to occur.

6.7.3.2 Sewer Pipeline Route

The proposed works will impact on known Aboriginal objects AWMF Pipeline Isolated Find 1 and AWMF Pipeline Midden 1, as described in **Table 6.32**. The proposed works may also impact on areas of archaeological sensitivity along the creek lines (Niche, 2011).

The pipeline impact footprint is generally limited to a 3.4km by 3m area which has previously been disturbed. The proposed works will impact on a portion of a midden and an Aboriginal Object; however, these site types are well represented in the wider landscape. Hence Niche (2011) concluded that overall, the proposed works will have limited impact on the wider cultural landscape of the region.

Information from the registered Aboriginal parties indicates that cultural values associated with midden sites and creek lines will be impacted by the proposed works, though these areas may have been assessed as having low archaeological significance (Niche, 2011).

Niche (2011) recommended further sub-surface investigations should be undertaken if AWMF Pipeline Midden 1 is to be impacted by the proposed works. Sub-surface testing should aim to determine the nature, extent and significance of the site.

6.7.4 Mitigation Measures

With regards to artefacts on the AWMF site, it is recommended that where possible, the identified modified tree artefacts remain in-situ. For the proposed design, this is feasible for AWTF_ST1 and AWTF_ST3, which are both located outside the works footprint. In order to minimise unintentional impacts during construction, it is recommended that a 5m buffer zone be placed around AWTF_ST1 and AWTF_ST3, using barrier tape or appropriate bunting/fencing to delineate the buffer perimeter. This is particularly important since both artefacts lie just outside the works footprint, so plant and other construction equipment are likely to be utilised within close proximity to the artefact sites. The adoption of a 5m protection zone around these trees was determined through consultation with the Aboriginal community. During the detailed design phase LMCC will investigate increasing this buffer zone to ensure, wherever possible, that it covers the extent of canopy cover for each tree (which is generally a reasonable indication of the extent of the tree root system), should the site constraints allow for it.

AWTF_ST2 is located in the western portion of the site and coincides with the works footprint. Given that this tree is already dead, it may be possible to relocate this artefact if project approval is granted and if impacts are unavoidable.

Site cards for all of the sites identified by the survey will be completed and their details lodged on the AHIMS system maintained by the OEH.

The preliminary testing narrowed down the area of archaeological sensitivity within the area of proposed impact to a level bench area on the north side of the creek within the southernmost proposed leachate basin around test probe 7. Should the project receive approval, it is recommended that additional excavation works be undertaken in this area prior to impact. This will initially comprise of 1m² probes spaced evenly over the area of impact along the creek line. These may be expanded if artefact densities warrant further investigation or salvage. Following completion of the archaeological sub-surface excavation works in this area, it is recommended that a monitoring and collection program is undertaken by the registered Aboriginal stakeholders during all proposed sub-surface excavations works for the project within the margins of the creek. It is recommended that Aboriginal stakeholders (Registered Aboriginal Parties) be engaged to monitor all sections of the excavations (ground surface impacts) to allow collection of any artefacts that may be disturbed in this area. Artefacts collected during this monitoring and collection process along with any artefacts salvaged from the sub-surface excavations should then be relocated and reburied on site by Aboriginal stakeholders at a location that will not be subject to any future impacts. This will ensure that any recovered artefacts will remain 'in country'. The artefacts would be recorded prior to reburial and their details and new location added to the OEH AHIMS Database.

It is recommended that a Cultural Heritage Management Plan (CHMP) be prepared for the project in partnership with registered Aboriginal stakeholders.

The CHMP should include procedures for ongoing Aboriginal consultation and involvement, management of all Aboriginal cultural heritage values associated with the project area, the responsibilities of all stakeholders, details of proposed mitigation and management strategies of all sites; including any additional investigation processes, salvage activities, monitoring, etc.; procedures for the identification and management of previously unrecorded sites (excluding human remains), and compliance procedures in the unlikely event that non-compliance with the CHMP is identified.

More specifically, the CHMP would outline the proposed additional excavation works in the area of impact within the southernmost leachate basin including methodologies for monitoring of surface disturbance works in this area and protocols for collection and reburial of artefacts by the registered Aboriginal stakeholders. The CHMP would also outline protocols for ongoing management of cultural heritage values including suggestions for the relocation of AWTF_ST2, its ongoing conservation and management. This will include further discussion on potential impacts during artefact relocation, should it be required, and the development of appropriate mitigation strategies to avoid any additional impacts as a result of relocation. It is also recommended that cultural heritage awareness training be implemented through an oral and/or PowerPoint presentation for all personnel and contractors involved in the project. To formalise this training LMCC should develop and implement an Aboriginal Cultural Heritage Induction Program for all personnel associated with the project. Details of the Aboriginal cultural heritage education program should be included in the CHMP.

The CHMP should demonstrate that effective community consultation with local Aboriginal communities has been undertaken in the development and implementation of the plan. Evidence of consultation and views of the community for the CHMP should also be included.

Under the *National Parks and Wildlife Act 1974*, “stop work” provisions must be adhered to by construction contractors and all other on-site employees in the event that any bone or stone artefacts, discrete distributions of shell or any other objects of potential cultural association are uncovered during earthmoving or other activities. In such a case, work should cease immediately in the area of the find. The on-site environmental officer would be contacted immediately and would arrange for a suitably qualified archaeologist to examine the find and advise on an appropriate course of action. This course of action would be undertaken prior to any further work being conducted within the vicinity of that location.

The registered Aboriginal stakeholders for the project have also requested that the proponent take all necessary steps to locate, protect and preserve Awabakal Cultural Heritage.

With regards to artefacts along the sewer pipeline route, Niche (2011) similarly recommended that a suitable testing methodology should be designed to test for potential sub-surface archaeological deposits in areas of archaeological sensitivity along the creek lines along the pipeline route.

Niche (2011) recommended that a suitable testing methodology should be designed so as to determine the nature, extent and significance of the midden site identified along the pipeline route. In accordance with NSW legislation the relevant OEH Environmental Protection and Regulation Division regional office must be notified in writing at least 14 days before undertaking any test excavations.

6.7.4.1 Response to Aboriginal Stakeholders

A summary of the issues raised by the registered Aboriginal parties and the corresponding management recommendations to address these issues is presented in **Table 6.36**.

Table 6.36: Summary of Issues Raised by Registered Aboriginal Parties and Subsequent Management Recommendations (Insight Heritage, 2011 and Niche, 2011)

Issue	Management Recommendations
Impacts on Aboriginal cultural heritage.	The proposed works are likely to impact on identified AWTF_ST2 and the area of identified sensitivity adjacent to the creek line at the AWMF site. It has been recommended that AWFT_ST2 be relocated into a conservation area that will not be impacted by development. It is also recommended that further sub-surface salvage works are undertaken in the area of identified sensitivity adjacent to the creek line. The proposed works should not impact on identified sites AWTF_ST1 and AWTF_ST3.
A Cultural Heritage Management Plan is required if the proposal is to proceed.	The Insight Heritage (2011) and Niche (2011) reports recommended that a CHMP is developed in consultation with the registered Aboriginal stakeholders if project approval is received prior to the commencement of project works.
Impacts on the identified possible culturally modified trees at the AWMF site. Management of the modified trees should to be discussed with the registered Aboriginal parties if impacts are unavoidable.	The report concludes that impacts on AWTF_ST1 and AWTF_ST3 at the AWMF site should be avoided and recommends a buffer area be placed around the tress during construction to avoid unintentional impacts. It has been recommended that AWFT_ST2 be relocated into a conservation area that will not be impacted by development.
Further information is required concerning additional impacts on the relocation of AWTF_ST2 at the AWMF site.	The CHMP will outline the protocols of the relocation and ongoing management of AWTF_ST2 at the AWMF site to ensure that appropriate mitigation measures are employed during the relocation process and for ongoing management. These will be discussed and refined with the registered Aboriginal parties for the project. The aim of the CHMP will be to ensure that the relocation of AWTF_ST2 is undertaken in an appropriate manner according to best practice methodologies and agreed upon by the registered Aboriginal parties.
Additional sub-surface salvage/testing works should be undertaken in the area of impact within the margins of the creek lines.	The management recommendations include further sub-surface archaeological testing/salvage works in this area. Along the pipeline route in particular Niche (2011) has recommended further sub-surface testing of the midden site identified during the pipeline survey.
There is need for an observation and collection strategy by registered Aboriginal parties for all sub-surface excavations within the margins of the creek.	Following additional sub-surface testing/salvage works in the area of impact adjacent to the creek line at the AWMF site it is recommended that a monitoring and collection program be undertaken by the registered Aboriginal parties. Niche (2011) recommended that a monitoring and observation program should be implemented along the entire pipeline route so that

Issue	Management Recommendations
	registered Aboriginal parties are allowed to collect any artefacts that may be disturbed during the excavation stage of the pipeline.
Any Aboriginal artefacts recovered from the salvage works require reburial “in country”.	Artefacts collected during the monitoring and collection process along with any artefacts salvaged from the sub-surface excavations would be relocated and reburied on site by the Aboriginal Stakeholders at a location that will not be subject to any future impacts. This process should be carried out by the registered Aboriginal parties and recorded by an archaeologist and the co-ordinates submitted to the OEH AHIMS Database.
There is potential for Aboriginal objects to be concealed below the surface within the project area.	The initial testing works at the AWMF site recovered an artefact and identified an area of archaeological sensitivity adjacent to the creek line in the proposed location for the southernmost leachate basin. The testing identified that the soil became shallower and was more highly disturbed upslope from the area adjacent to the creek line. The report by Insight Heritage (2011) recommends further salvage / sub-surface excavations works are undertaken in the area adjacent to the creek line which will be impacted by the development. This will be followed by a monitoring and collection programme that will be further refined in the CHMP. The report by Niche (2011) similarly recommends further sub-surface testing of the midden site identified during the pipeline survey and their report proposes a recommended sub-sub-surface testing methodology.
Contractors and staff on site at the AWMF and along the pipeline route should be aware of the cultural heritage issues present.	It is recommended that a cultural heritage awareness training program be developed and implemented for site contractors and staff during construction, particularly those undertaking any excavations within the footprint of the proposed development area. This may be included in the site induction process for staff and contractors.

6.8 Non-Aboriginal Heritage

Fifteen database-listed, non-Aboriginal heritage items were identified as part of the assessment, however none of these items are located within the site or pipeline route boundary. No impacts on non-Aboriginal heritage items are anticipated as a result of the proposed works.

6.8.1 Introduction

The sections below examine the existing environment in the context of non-Aboriginal heritage and historical use and consider the potential impacts of the construction and operation phases of the proposed additions to the AWMF and the sewer pipeline on heritage listed items and places nearby. Mitigation measures have also been recommended to manage impacts on heritage.

6.8.2 Existing Environment

LMCC (2011b) identify that the township of Awaba was established in the late 1800s, with early settlers generally originating from nearby areas such as Mullbrig, Brunkerville and Mount Vincent. Awaba has a history of industry, with early developments including a sawmill, timber depot, railway construction depot and later a State Coal Mine (established in 1948).

Also noteworthy in the area surrounding the AWMF site is the former Rathmines RAAF Base, in the suburb of Rathmines, which had a profound effect on post WW2 development in Lake Macquarie. Rathmines was the largest flying boat base in Australia with the "Seaplane Training Flight", seamanship and gunnery courses, a major communications centre, trades training and the principal repair shops for all flying boats (Heritage Branch, 2011b).

In order to ascertain the presence of heritage items and places within the study area, a search of the following online databases was conducted for the suburbs of Awaba and Rathmines (and Toronto but only in the vicinity of Wilton and Wangi Roads) on 24 October 2011:

- The Australian Heritage Database (DSEWPaC) – for heritage items and places of national significance;
- The State Heritage Register (OEH Heritage Branch) – for heritage items and places of state and local significance;
- State Rail Authority (STA) Section 170 Register;
- Roads and Maritime Services Section 170 Register (no items listed); and
- Lake Macquarie LEP 2004 – Schedule 4 (Heritage items).

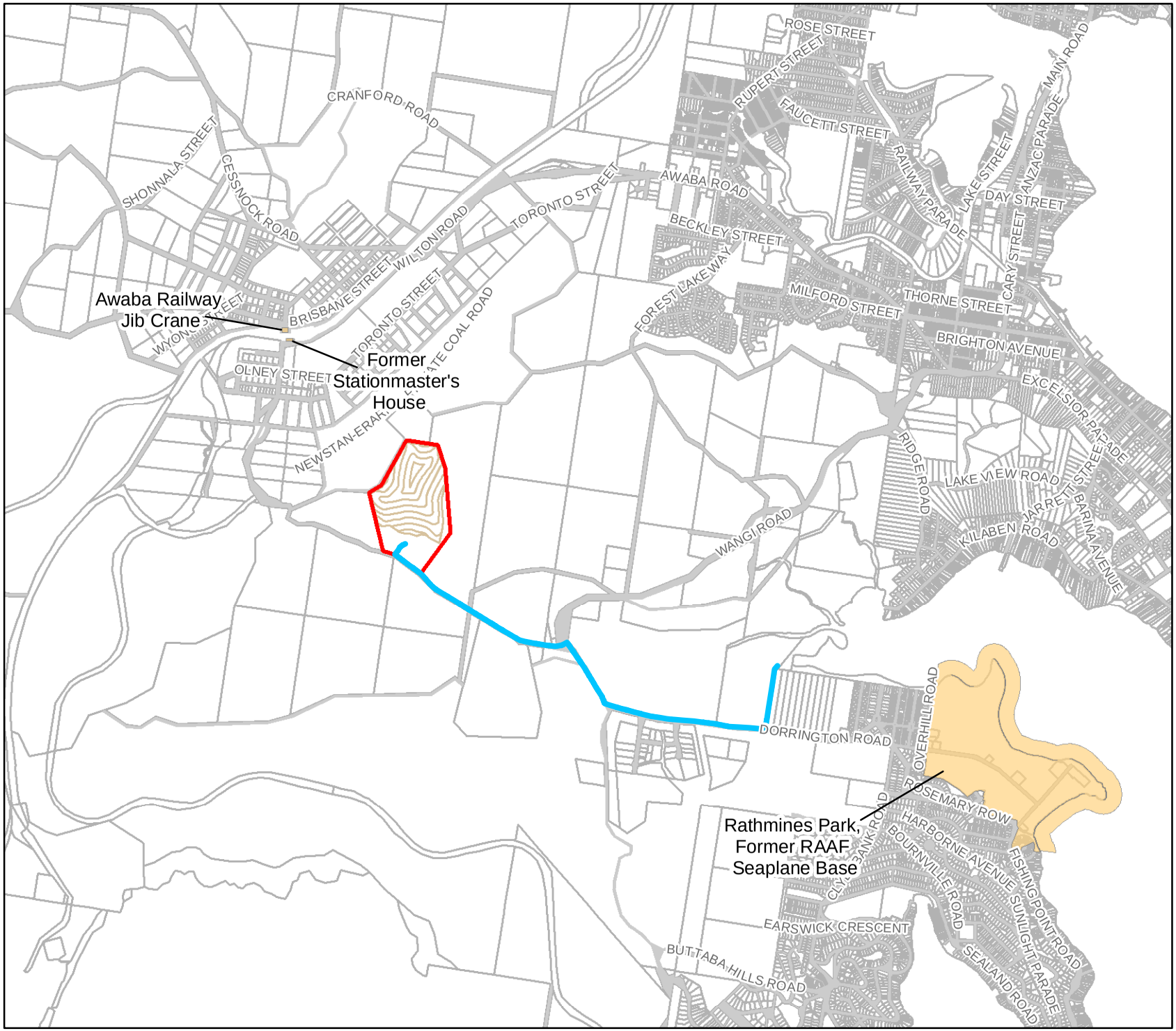
Table 6.37 presents the findings of the database searches, with items shown on **Figure 6.24**.

Table 6.37: Results of Heritage Database Searches

Name	Location and/or Lot DP	Level of Significance	Listing	Description
Rathmines Park	Dorrington Road, Rathmines (Lots 37-51 DP 11537, Lot 1 DP 226530, Lot 2 DP 226531, Lot 3 DP 226532, Lot 4 DP 226533, Lot 5 DP 226534, Lot 7 DP 516152, Lot 60 DP 584602, Lots 62-64 DP 596913, Lot 4 DP 704472 and Lots 648 and 654 DP 806611)	National and State	National Heritage Register (nomination now eligible for PPAL) and *Heritage Act 1977* – State Heritage Register	The Rathmines RAAF Base is a 61ha site on the western shore of Lake Macquarie, now a popular sporting and recreational area. The site was an important base for the Catalina flying boats and their Squadrons, which played a significant role in Australia's RAAF defensive operations during World War II.
Former Rathmines RAAF Seaplane Base	Overhill Road, Rathmines	National and State	Register of the National Estate (Indicative Place) and *Heritage Act 1977* – State Heritage Register	Approximately 30ha in Rathmines Park, bounded by Lake Macquarie at Style Point in Kilaben Bay and Dorrington Road. The base played a pivotal role in the defence of Australia in World War II.
Awaba Railway Jib Crane	Off Adelaide Street, Awaba	State	*Heritage Act 1977* – STA Section 170 Register	The crane at Awaba railway station dates from the 1930s and was installed to assist with the loading and unloading of goods vehicles. The crane has historical significance as the only remaining physical evidence of the once busy former goods siding on the down side of the line at Awaba. The crane is considered rare as one of only a few cranes that still remain in railway ownership in the metropolitan network, and the only one to remain along the main north line (Heritage Branch, 2011a)
Former Stationmaster's House (Gatekeeper's Cottage)	1 Wilton Road, Awaba (Lot 1 DP 817297)	Local	*Lake Macquarie LEP 2004*	A typical, mostly intact and attractive example of railway housing of its period, in a prominent position next to the station, so that its historic relationship with the railway station is quite evident.
Boat Slip, Lake Macquarie Shore	1 Overhill Road, Styles Point, Rathmines (Lot 64 DP 596913)	Local	*Lake Macquarie LEP 2004*	The boat ramp was part of the RAAF Rathmines Base Ship Repair section.

Name	Location and/or Lot DP	Level of Significance	Listing	Description
Brick Store	1 Overhill Road, Stilling Street, Rathmines (Lot 64 DP 596913)	Local	*Lake Macquarie LEP 2004*	Former RAAF Rathmines Base Stores building - one of several brick stores on the site.
Catalina Memorial Nursing Home	171 Dorrington Road, Rathmines (Lot 2 DP 226531)	Local	*Lake Macquarie LEP 2004*	Former RAAF Base Hospital.
Catalina War Memorial, Catalina Park	1 Overhill Road, east of the Stilling Street Loop, Rathmines (Lot 64 DP 596913)	Local	*Lake Macquarie LEP 2004*	The monument is built on a knoll above Lake Macquarie, close to the former RAAF Officers' Mess.
Catamaran Club	1 Overhill Road, off the east side of Stilling Street, Rathmines (Lot 64 DP 596913)	Local	*Lake Macquarie LEP 2004*	Lake Macquarie and Newcastle Catamaran Club was the former RAAF barracks and office building.
Flying Boat Slips or Ramps, Rathmines RAAF Base	1 Overhill Road, off the west side of Stilling Street, Rathmines (Lot 64 DP 596913)	Local	*Lake Macquarie LEP 2004*	A very wide concrete ramp or slip running down into the water of Lake Macquarie and backed by an extensive concrete apron on which there was room for a number of aeroplanes to stand.
Community Hall	1 Overhill Road, Stilling Street opposite Dorrington Road, Rathmines (Lot 64 DP 596913)	Local	*Lake Macquarie LEP 2004*	Formerly the RAAF Rathmines Airmens' Recreational Centre (Other Ranks' Mess).
Rathmines Bowling Club	1 Stilling Street, Rathmines (Lot 4 DP 226533)	Local	*Lake Macquarie LEP 2004*	Former RAAF Rathmines Base Officers' Mess.
Christadelphian School	2 Stilling Street, Rathmines (Lot 5 DP 226534)	Local	*Lake Macquarie LEP 2004*	Christadelphian Bible School was the former RAAF Rathmines Base Workshops.
Rathmines Holiday Camp	3 Stilling Street, Rathmines (Lot 1 DP 226530)	Local	*Lake Macquarie LEP 2004*	Former RAAF Rathmines Base Sergeants' Mess.
Emergency Radio Bunkers	115 Wangi Road, Rathmines (Lot 446 DP 1138964)	Local	*Lake Macquarie LEP 2004*	Former RAAF Rathmines Emergency Radio Bunker

All except three heritage items listed in **Table 6.37** are associated with the former Rathmines RAAF Base and are located within the area of Rathmines / Catalina Park (towards the eastern end of Dorrington Road). The Park is located over a kilometre to the east of the WWPS, which is the most eastern extent of the proposed works (for the sewer pipeline connection).



Non-Aboriginal Heritage Items in Site Surrounds

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

- Site Boundary
- Design Contours
- Proposed Sewer Pipeline
- Non-Aboriginal Heritage
- Road Corridors
- Cadastre

FIGURE 6.24

1:35,000Scale at A4

Metres

0 100200 400 600 800

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Project: 600308
Map: G6024_Non-AbHerItems.mxd 02

6.8.3 Potential Impacts

All the items described in **Table 6.37** are located outside the direct footprint of the works: Lot 372 DP 723259 and the road reserves of Wilton, Wangi and Dorrington Roads and the access road to the Rathmines No. 6 WWPS (see **Figure 6.24**), hence there should be no direct impacts on any of these heritage items due to the proposed works. There is the potential that construction vehicles could accidentally damage heritage listed items in the local vicinity when using the local roads to access the site area; however, due to the location and type of items listed in **Table 6.37**, this is considered unlikely.

Potential indirect impacts on these items may include vibration impacts from construction trucks and other vehicles using nearby roads during the construction and operational phases. However, construction trucks movements are unlikely to occur further east along Dorrington Road beyond the access road to the WWPS. Hence vibration impacts should not affect the majority of heritage items, which are located within the Rathmines / Catalina Park area at the eastern end of Dorrington Road and associated with the Rathmines RAAF Base.

It is anticipated that there will be minimal increases in traffic movements in the local area during the construction and operational phase of the works (**Section 6.11**), and so indirect vibration impacts on heritage items are not expected to be an issue.

In addition, the condition of the road surface in the vicinity of 1 Wilton Road (Lot 1 DP 817297) and 115 Wangi Road (Lot 446 DP 1138964) is considered to be particularly important in determining the impacts of vibration on these historic buildings (Hume, 2007). During a site inspection conducted on 7 April 2011, a visual assessment found that Wilton and Wangi Roads in the vicinity of these two historic buildings are generally in good condition. Although Wilton Road represents a main thoroughfare that links the AWMF site to the Sydney-Newcastle Freeway (F3), the northern section of the road in the vicinity of Lot 1 DP 817297 is conducive to an acute reduction in vehicle speed due to the presence of a 90 degree turn opposite Awaba railway station. Given the relatively good condition of the road surface on the relevant sections of Wilton and Wangi Roads, vibration impacts on the two heritage listed buildings from operational road traffic are not anticipated. Vibration is further discussed in **Section 6.13**.

6.8.4 Mitigation Measures

Use of Wilton Road by construction traffic at its northern end (adjacent to the railway line and in the vicinity of Lot 1 DP 817297) and use of Wangi Road by construction traffic south of the intersection with Dorrington Road (in the vicinity of Lot 446 DP 1138964) should be minimised where possible. Traffic routes to access the works site and any restrictions to avoid heritage items in the vicinity of the works should be specified in the Construction Traffic Management Plan (see **Section 6.11**).

All site personnel should be made aware of the presence of the heritage items in the general locality of the works, such that the potential for accidental damage to these heritage items is minimised.

If vibration impacts from nearby road traffic appear to be adversely affecting any heritage building or structure, works and traffic movements in the vicinity should be stopped immediately, and OEH (Heritage Branch) informed. Further investigation should then be undertaken by suitably qualified professionals.

6.9 Visual Landscape

Impacts during the construction phase of the works are anticipated to be minimal due to screening vegetation and local topography providing a visual barrier to the site from surrounding potential viewpoints. The eventual emplacement of additional landfill within the proposed AWMF extension may have visual landscape impacts, particularly for the suburb of Awaba, located approximately 800m to the north-west of the site. Visual impacts for this suburb are likely to include the visibility of the emplacement area above the existing ridgelines. Progressive revegetation of the landfill emplacement will minimise these impacts.

Views from the suburbs fronting the eastern and western foreshores of Lake Macquarie are unlikely to be significantly impacted by the proposed additions to the AWMF

6.9.1 Introduction

This section provides an assessment of the visual impacts likely to be associated with the proposed AWMF extension works and sewer pipeline connection to the existing Rathmines No. 6 WWPS. It considers the potential impacts on visual amenity and scenic quality on a local and regional scale and describes measures to mitigate against such impacts.

6.9.2 Existing Environment

The AWMF is situated on undulating terrain, and the highest point of the site is currently 82.6m AHD, with the site sloping down from the north-west to the south-east (LMCC, 2011). Slope angles are typically 5-10% over most of the AWMF site with a smaller area of 15-20% slope immediately north of the entrance road. This topography is typical of the landforms throughout the lower Hunter Region. The site itself is generally cleared of trees, but tall, open woodland forest (with trees generally 10m high) lies to the north, south, east and west which limits the visibility of the AWMF site from local areas.

Wilton Road lies to the south of the site and connects with the wider road network including Wangi Road to the east and the F3 to the west. Wangi Road runs generally in a north-south direction, with the Toronto Golf Course located immediately to the east of the road in the vicinity of the sewer pipeline works. Dorrington Road connects Wangi Road to the residential areas in the suburb of Rathmines, ending in Rathmines and Catalina Parks, near the eastern shores of Lake Macquarie.

Regional landscape features include the Lake Macquarie water body to the east of the subject site and distant views of relatively intact vegetated hills (several of which have transmission towers).

Low density residential land uses form part of the landscape and are particularly concentrated in the vicinity of the Lake Macquarie water body to the east of the site (such as the suburb of Rathmines), and also in the township of Awaba, located approximately 800m north-west of the site. In addition to residential land uses, the surrounding area includes industrial, commercial, recreational and rural land uses, as well as "special land uses" such as road and rail infrastructure. Closer to Lake Macquarie, the Eraring Power Station is a dominant landscape feature.

6.9.2.1 *Visual Quality of Existing Environment*

Table 6.38 describes the key landscape features surrounding the subject site and gives a subjective indication of the visual quality of the features to provide an overall appreciation of the visual nature of the surrounding landscape.

Table 6.38: Key Existing Landscape Features and Associated Visual Quality

Landscape Feature	Description	Visual Quality
Undulating topography with tall open woodland forest	Undulating topography, steep in parts, with generally undisturbed open woodland forest consisting of trees generally 10m high.	High
Ridgeline development	Development on ridgelines including transmission towers and access paths (private roads and access paths, fire access trails, etc.).	Low
Lake Macquarie	Lake Macquarie has an area of approximately 105km^2 and lies approximately 3.5km west of the coastline.	High
Developed foreshore areas	The foreshore of Lake Macquarie is developed in many areas, primarily with residential land uses.	Low-moderate
Road network	Roads traverse the landscape in numerous places, with a concentration of residential roads in foreshore areas and more major roads generally being located on hills or ridgelines (e.g. Wangi Road).	Low

6.9.2.2 *Existing Site Visibility*

The existing AWMF site is currently not easily visible from adjoining lands, roadways, residential precincts and or other places of interest. There are no foreground static or transient views of the site from the local road network, and similarly, distant static or transient views of the site are not easily obtainable, particularly from residential precincts of the greater area. This is due to the topography of the AWMF site and surrounding land, the surrounding and screening vegetation, the remoteness of the site and the current height of the landfill emplacement (LMCC, 2010).

Similarly, Wilton, Wangi and Dorrington Roads along the sewer pipeline route are generally not easily visible from adjoining lands and surrounding residential precincts due to the surrounding vegetation, which screens the roadways.

However, the vegetation screening Wangi and Dorrington Roads from the Toronto Golf Course is not dense and as such works to install the sewer pipeline along these roadways will be partially visible to users of the golf course during the construction phase.

Figure 6.25 provides an indication of the existing landscape features in the areas surrounding the subject site. The view looking west from the wharf off Soldiers Street, Pelican shows Lake Macquarie in the foreground and residential land uses, industrial infrastructure (Eraring Power Station and Myuna Colliery) and undulating terrain in the background. The view looking south-east from Adelaide Street, Awaba shows road infrastructure in the foreground, railway and electricity infrastructure in the middle-ground and undulating terrain in the background.

a) Existing view from the wharf off Soldiers Street, looking west (10/04/2011)

b) Existing view from Adelaide Street, Awaba, looking south east (10/04/2011)

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Views and Landscape Features

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Cardno

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Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6025_Views_portrait.mxd 02

FIGURE 6.25

6.9.3 Potential Impacts

The eventual emplacement of additional landfill within the proposed AWMF extension has the potential to affect the scenic quality of the locality, when viewed at a distance (LMCC, 2010). As described above, the highest point of the site is currently 82.6m AHD, and the project proposes an eventual emplacement height of approximately 110m AHD by approximately 2032 (LMCC, 2010).

In order to determine the extent of long term potential impacts of the proposed additions to the AWMF on the local and regional viewshed, visual amenity and landscape character, a visual impact assessment was undertaken and is discussed below.

Methodology

Site visits were conducted on 10 April 2011 and 4 May 2011 to undertake an assessment of the landscape and views towards the AWMF site. A series of photographs were taken.

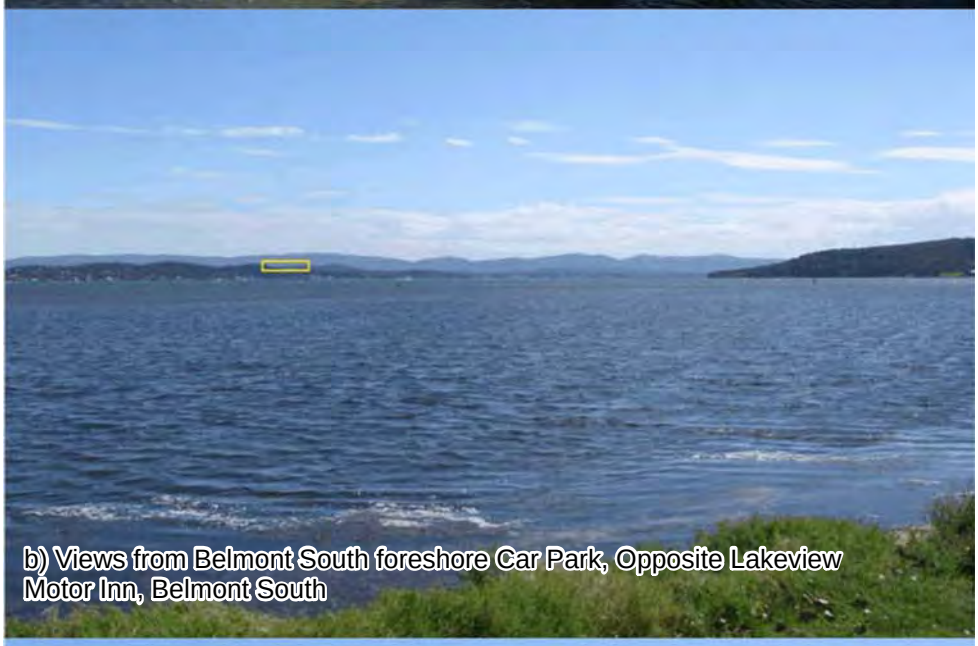
The site visits revealed that views from the suburbs of Wangi Wangi, Buttaba, Rathmines, Kilaben Bay, Coal Point, Eleebana, Valentine, Belmont, Belmont South, Marks Point and Pelican were unlikely to be significantly impacted by the proposed additions to the AWMF in terms of visual amenity. This is due to the distance from the site (for suburbs located on the eastern side of Lake Macquarie) and vegetation screening and topography (for suburbs located on the western side of Lake Macquarie).

Figure 6.26 shows views from three locations looking west across Lake Macquarie towards the AWMF site. The yellow boxes highlight the approximate location of the AWMF and provide an indication of the distance from the site.

An area of long term potential visual impact is located in the suburb of Awaba, approximately 800m to the north-west of the site. This area consists primarily of residential land uses, with some other commercial, industrial and special land uses such as the railway line. Views from Awaba towards the AWMF site, when not obstructed by vegetation and topography, are obtainable looking in a south-east direction.

Two viewpoints in the Awaba village were selected as representative views to be used in the visual assessment. These viewpoints are located in central Awaba and were chosen because a higher level of visual impact is anticipated to be experienced at these locations. Viewpoints in the south-western parts of Awaba are not as likely to be subjected to long term visual impacts as a result of existing vegetation screening and topography and were therefore not assessed. The location of the two chosen viewpoints is provided as **Figure 6.27**.

a) Views from Pelican Jetty, Soldiers Street, Pelican



b) Views from Belmont South foreshore Car Park, Opposite Lakeview Motor Inn, Belmont South

a) Views from Victoria Street, Near Cliff Street, Belmont

Views Towards the Site From the Eastern Side of Lake Macquarie

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY
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Approximate Site Location

FIGURE 6.26

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Date: 2012-04-26
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Project: 600308
Map: G6026_ViewsTowardsSite_portrait.mxd 02

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Two Representative Viewpoints in Awaba

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Legend

- Site Boundary
- Representative Viewpoints
- Design Contours
- Road Corridors
- Cadastre

N
W E
S

FIGURE 6.27

1:15,000 Scale at A4

Metres

0 50 100 200 300 400

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6027_AwabaViewpoints.mxd 02
Imagery supplied by LMCC and associated third party suppliers

Three dimensional (3D) representations of the proposed emplacement were prepared using Geographical Information Systems (GIS) and associated 3D modelling software. Photographs from the two Awaba viewpoints were then superimposed to provide an indication of the design profile of the ultimate landfill emplacement. The photographs provide an indication of views towards the south-west and west-south-west.

The assessment was conducted in accordance with the proposed staging of the works, and so each viewpoint has a representation for Stage A (**Figure 6.28**), and stages B and C (**Figure 6.29**), with Stage C representing the "worst case" scenario. Staging of the works is discussed in detail in **Section 6.4**.

6.9.3.1 Construction Phase

At the AWMF site visual impacts associated with the construction phase would result from vegetation clearing and the additional use of plant. Overall, impacts during this phase of the works are anticipated to be minimal due to screening vegetation and local topography providing a visual barrier to the site from surrounding potential viewpoints.

Along the proposed sewer pipeline route the key short term visual impacts of the trenching and installation works will include construction associated vehicles and equipment, site facilities and stockpiles of materials located within the road reserves. As these impacts are short term in nature they are not considered to be significant.

There will be no long term impacts of the sewer pipeline component of the proposed works once construction is complete as the pipeline is located underground, the trench will be backfilled and any disturbed vegetation in the road reserves will be re-instated.

6.9.3.2 Operational Phase

The visual assessment indicates that the proposed additions to the AWMF will generate impacts on the visual amenity and landscape features of the area, with impacts primarily being observed in the suburb of Awaba.

The proposal will be undertaken in three major stages (Stages A, B and C), which includes 11 sub-stages. This staging of the works would accommodate a substantial temporal buffer prior to visual impacts being experienced by potential receivers (i.e. visual impacts would not be as noticeable in the early stages of the proposal), as demonstrated in **Figure 6.28** and **Figure 6.29**.

Table 6.39 outlines the staging plan for the works in terms of estimated time-frames for completion. Staging is discussed in more detail in **Section 6.4**.

Table 6.39: Staging of the Proposed Works

Stage	Description	Estimated Stage Completed
A (sub-stages A1-A3)	North-eastern cells to be filled	February 2018
B (sub-stages B1-B4)	Western cells to be filled	December 2025
C (sub-stages C1-C4)	Remaining cells on south-eastern side to be filled	December 2032

The estimated completion date shown

Table 6.39 represent a "worst-case" scenario, given that if the objectives of LMCC's waste strategy are adequately fulfilled, higher volumes of waste would be avoided, reused or recycled and minimal wastes would be transported to landfill. This would mean that the life of the landfill would be extended and visual impacts would be substantially postponed.

The results of the visual assessment are provided in the form of photographic montages, as shown in **Figure 6.28** and **Figure 6.29**. It should be noted that the visible surface of the eventual landfill emplacement would be landscaped and revegetated so that colours and visual textures would complement and blend in with the surrounding landscape. The colour of the emplacement in **Figure 6.28** and **Figure 6.29** has been chosen purely for illustrative purposes.

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Stage A - Views From Viewpoints 1 and 2

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

Proposed Emplacement

FIGURE 6.28

Cardno

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Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6028_ViewpointsStageA.mxd 02

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Stage B and C - Views From Viewpoints 1 and 2

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

Proposed Emplacement

FIGURE 6.29

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6029_ViewpointsStageB.mxd 02

The visual impacts at the end of Stage A of the AWMF expansion works can be considered as reasonably insignificant, due to the small scale of the emplacement at that time. Stage B has more significant visual impacts, with a larger emplacement area being visible beyond the existing ridgelines. The visual impacts at the end of Stage C are virtually indistinguishable from Stage B, and this is due to the placement of the emplacement cells such that Stage C cells are positioned behind Stage B cells when viewed from vantage points in Awaba.

Visual impacts will be detected from the time that the emplacement has been filled to a level above surrounding ridgelines. During each stage, excavation and filling of landfill cells will require the use of on-site plant and machinery, and this equipment may be perceivable in the distance from nearby vantage points during these times. Operations at the site would only occur during daylight hours, and as such there would be no light emissions from the site. However, if night works are required, due to the remoteness of the site light emission impacts will be minimal.

Progressive covering of the emplacement with daily cover material would be undertaken throughout the operational life of the landfill and as such, any visible tip face would be dominated by earthy tones. Landscaping would be undertaken progressively (and as early as possible) on completed cells so that the visible tip face would be kept to an absolute minimum.

Table 6.40 provides a comparison of the visual quality of landscape features described in **Table 6.38**, for the existing case and each stage of the proposed AWMF expansion works. The levels of visual quality represent a qualitative analysis only, based on the results of the visual assessment. **Table 6.40** indicates that visual impacts on one landscape feature only would be likely (undulating topography with tall open woodland forest), but significant impacts are only likely to be experienced for one operational stage of the proposed AWMF expansion development (Stage B). Impacts are not likely to be substantial once revegetation of the site has occurred in Stage C, nor at the end of the landfill life, once all landscaping, revegetation and rehabilitation works have been completed.

Table 6.40: Comparison of Existing/Proposed Landscape Features and Associated Visual Quality

Landscape Feature	Visual Quality				
	Existing	End of Stage A	End of Stage B	End of Stage C	End of landfill life
Undulating topography with tall open woodland forest	High	High	Moderate-high	High	High
Ridgeline development	Low	Low	Low	Low	Low
Lake Macquarie	High	High	High	High	High
Developed foreshore areas	Low-moderate	Low-moderate	Low-moderate	Low-moderate	Low-moderate
Road network	Low	Low	Low	Low	Low

6.9.4 Mitigation Measures

The Contractor could incorporate shade cloth with the site fencing along the road reserves to minimise the short term visual impacts of the sewer installation works on road users and commuters. Other than this no specific mitigation measures are proposed for the short duration works to install the sewer pipeline.

The staging of the proposed expansions to the AWMF assists in the mitigation of the visual impacts of the expanded landfill on nearby areas, with the early stages of the development having minimal impacts on the visual quality of the surrounding landscape. Wherever possible, existing vegetation will be retained so that natural visual screens remain in place throughout the works. The anticipated year of landfill exhaustion (2032) may not eventuate if local waste distribution is shifted such that a reduction in landfill volumes occurs, whilst reused, recycled and avoided waste volumes increase (in accordance with LMCC's waste strategy). Decreases in landfill volumes would mean that the life of the landfill would be extended and visual impacts would be correspondingly postponed.

The visual impact of the landfill is currently mitigated through regular concealment of the landfill face using daily cover, which allows colour blending to occur and reduces the contrast of lighter colours in the emplacement. This consistent covering of the emplacement would continue in the operational phase of the proposed extension to the AWMF to mitigate potential visual impacts.

Once reaching capacity, revegetation and rehabilitation would be undertaken so that effective concealment of the emplacement would be achieved in the long term. As each cell reaches capacity, the revegetation and rehabilitation process would be undertaken progressively so that revegetation is maximised and visual impacts are minimised. Landscaping would be undertaken as early as possible so that the area of visible tip face from local vantage points would be kept to an absolute minimum. Consideration would also be given to native vegetation species that are characterised by rapid and dense growth so that visual impacts may be mitigated sooner. A VMP would be prepared for the proposed works, and this would detail vegetation types, densities, staging etc. Further detail regarding the VMP is provided in **Section 6.5**.

6.10 Greenhouse Gas (GHG)

The expansion of the AWMF will result in additional emplacement of landfill over the long term that is likely to lead to an increase in GHG emissions from the site. Assessment results indicate that predicted annual average GHG emissions over the period 2011 – 2100 will be double the current annual GHG emissions generated from the landfill. However, this does not take into account any positive impact on emissions that may result due to planned future activities to divert some reusable and recyclable waste.

6.10.1 Introduction

The operation of a putrescible landfill facility produces greenhouse gas (GHG) emissions both in the storage of the waste (i.e. through waste decomposition) and operation of site facilities and equipment. Cardno has undertaken a quantitative assessment of both scope 1 (direct) and scope 2 (indirect) GHG emissions for the proposal. This comprises an assessment of the known existing operating conditions, facilities and equipment against future expected levels under the proposed expansion. A 90 year assessment period, from 2011 to 2100, has been used for a consistent comparison.

A landfill gas collection system will be installed in the new landfill cells, including in the areas above the existing landfill areas, to expand the current gas collection system. The proposed gas collection system is shown on **Figure 1.2**. The collection system will be installed in the waste above the foundation layer and membrane within these areas. The collection system will comprise a network of gas manifolds and extraction wells that will feed into the existing landfill gas engines that generate electricity on site. The capacity of the gas engine plant will be upgraded as required to accommodate the increased quantities of landfill gas generated and collected. Excess electricity generated will be fed back into the grid.

GHGs are relevant to the new landfill areas, as the proposed facility additions will extend the life of the existing landfill and increase its capacity, requiring an upgraded gas collection system. GHG emissions associated with the operation of significant proposed additional facilities have also been incorporated into the assessment, including the waste transfer station, additional reuse centre and package pumping station at the AWMF, and the additional waste trucks required on site.

It should be noted that the GHG calculations presented below are included in this EA to meet the requirement to consider climate change under Part 3A of the EP&A Act. These calculations and reported results do not form the official basis of potential future reporting that may be required by LMCC under the *National Greenhouse and Energy Reporting Act 2007* (NGER Act).

6.10.2 Existing Environment

An existing landfill gas collection system is in place within the existing landfill areas at the AWMF site.

LFG generated at the Site is currently managed by an active LFG collection and treatment system that is designed, installed and operated by a specialist LFG management contractor. The term “active” indicates that LFG is extracted from the waste mass using a fan (or blower), which directs the extracted gas to the treatment plant (flare or engine).

LFG treatment at the Site is predominately via combustion In a LFG fuelled Engine that drives a generator to create renewable electricity. It is understood that during periods of Engine downtime, or when otherwise required, LFG can be directed to a LFG flare located at the Site.

The LFG Collection and treatment system at the Site has been designed to ensure adequate management of any Condensate formed within the system. LFG is a “wet” gas and Condensate is the term used for water vapour that was originally entrained within the LFG and subsequently condenses out from the LFG as it cools within the collection pipework. Condensate formed within the collection pipework at the Site is managed via a combination of pipework grading and a series of Condensate drainage/collection points. The Condensate which is formed within the pipework at the Site ultimately drains back into the waste mass.

The majority of the LFG collection and treatment systems at the Site are buried below ground level (with the exception of the Engine, the Flare, some of the Condensate collection/drainage points and the Well Stations).

Further details of the existing (and proposed) landfill gas management systems can be found in **Appendix Q.**

This system will be retained in an operational state to recover methane from the existing waste below the “piggyback” system after it has been installed on top of the current landfill cells.

6.10.2.1 Greenhouse Gases

GHGs are gases that contribute to global warming, known as the Greenhouse Effect. There are several GHGs, and they all have varying Global Warming Potential (GWP). The higher the GWP of a gas, the more impact each tonne of that gas has on the Greenhouse Effect.

In order to standardise GHGs for reporting and accounting purposes, they can be expressed as tonnes of carbon dioxide equivalent emissions (T CO_2-e), where carbon dioxide has a GWP of 1. One of the most significant GHGs for landfill sites is methane (CH_4), which has a GWP of 21; hence one tonne of methane has a Greenhouse Effect equivalent to 21 tonnes of carbon dioxide. The GWP of the six GHGs used in carbon accounting (the Kyoto GHGs) are shown in Table 6.41.

Table 6.41: Global Warming Potentials of GHGs (DCCEE, 2010a)

Greenhouse Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrogen oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140 - 11,700 (depending on the HFC)
Perfluorocarbons (PFCs)	6,500 (CF_4) - 9,200 (C_2F_6) (depending on the PFC)
Sulphur Hexafluoride (SF_6)	23,900

GHG emissions are categorised into three different scopes, either 1, 2 or 3, in accordance with the Intergovernmental Panel on Climate Change (IPCC) and Australian Government GHG accounting systems. These emission scopes are as follows (IPCC, 2006):

- Scope 1: Direct (or point source) emissions generated directly by the activity, e.g. emissions generated by the use of plant and equipment for landfill activities on site;
- Scope 2: Indirect emissions generated outside of the activities' boundaries to provide energy to the project, e.g. the use of electricity from the grid purchased and consumed for the activity; and
- Scope 3: Upstream and indirect emissions due to third party supply chains that are in direct relation to the project, e.g. extraction, production and transport of purchased materials and waste disposal of those materials offsite.

6.10.2.2 Greenhouse Gas Assessment

In order to determine GHG emissions for the existing landfill site and operations at the AWMF and also for future expected levels under the proposed expansion a quantitative assessment of the scope 1 and 2 GHG emissions for the site, with, and without the expansion has been undertaken. This assessment was undertaken in accordance with the *National Greenhouse Accounts (NGA) Factors* (DCCEE, 2010a) and *National Greenhouse and Energy Reporting System Measurement – Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia* (DCCEE, 2010b).

GHG emissions were firstly calculated for the AWMF landfill under existing conditions to 2100, with the landfill expected to reach capacity at the end of 2014 (Scenario 1). GHG emissions were then calculated for the AWMF landfill incorporating the proposed expansion to 2100, with the landfill expected to reach capacity at the end of 2032 (Scenario 2). It should be noted that once the landfill stops receiving waste at the end of its operational lifetime, methane emissions from the decomposing waste will continue to be generated by the landfill long beyond this time frame.

A GHG inventory has been prepared to provide a quantitative estimate of the potential scope 1 and 2 GHG emissions associated with the existing and proposed expanded AWMF landfill operations. The emission sources which have been included in the GHG inventory are listed under each scope in **Table 6.42**.

Table 6.42: Existing Landfill Emissions Included in GHG Inventory

Scope 1 – Direct Emissions	Scope 2 – Indirect Emissions
▪ Landfill gas (methane only) emissions due to decomposing waste ▪ The onsite use of fuel (both diesel and unleaded gasoline) by equipment and vehicles on site	▪ The onsite use of electricity purchased from the grid (including for the operation of the proposed additional reuse centre, waste transfer station and on-site package pumping station)

Vegetation cleared for the development of the existing AWMF landfill and the relatively minor extents of vegetation that will be removed to facilitate the proposed landfill expansion and additional facilities have not been accounted for in the GHG inventory, as the majority of this vegetation will be progressively cleared and reinstated over the landfill area once each cell reaches capacity, and because it is considered that the greenhouse gas emissions from the vegetation removal will be negligible in comparison to the greenhouse emissions from the decomposition of waste in the landfill. It has also been assumed that emissions from the transport of all waste to the landfill site are classified as scope 3 emissions, and hence these have not been included in the assessment.

Predicted GHG emissions for the existing (Scenario 1) and expanded (Scenario 2) AWMF landfill operations have been calculated on a total basis for the future 90 year period (2011 to 2100) and also on an annual basis over this 90 year period. The total and annual predicted GHG emissions for the two GHG emission scenarios are provided in **Tables 6.40** and **6.41** respectively.

For simplicity the following assumptions have been made:

- No vehicles or plant will be operated at the site beyond the operational lifetime of the AWMF landfill (2014 and 2032 for Scenarios 1 and 2, respectively);
- Methane gas from the landfill will continue to be captured and flared at a rate of 36% of the annual methane gas produced (based on LMS monthly landfill gas reports from 2005 to 2010), for a 25 year period beyond the operational lifetime of the AWMF landfill for both scenarios. 2% of this 36% will comprise flaring of methane gas, to conservatively account for generator maintenance and general system downtime;
- All electricity requirements on site are met by purchasing electricity from the grid;
- Electricity requirements will double once the expansion is complete due to electricity requirements for the waste transfer station, additional reuse centre and package pumping station electricity requirements (based on energy consumption data for the site provided by LMCC for the 2009/2010 financial year);

- The site will not be purchasing and consuming any electricity from the grid beyond the landfills operational lifetime (It is noted that some electricity will be required for pumping of leachate off site and aeration of leachate into the future following closure of the landfill however this is not considered significant in the context of the wider assessment);
- One additional light to medium weight diesel vehicle will be required on site full time for the proposed additional reuse centre and waste transfer station; and
- For simplification of calculations, despite the proposed existing and additional reuse centre on site, calculations have assumed that no waste entering the AWMF is diverted from landfill for reuse or recycling purposes (although in reality this is not and will not be the case).

The basis of the GHG emission predictions shown in **Tables 6.40** and **6.41** are provided in **Appendix O**. In general, they are based on a number of assumptions and also site-specific data where it was available. Based on the assumptions and simplifications made for the calculations, such as assuming that no waste entering the AWMF is diverted from landfill for reuse or recycling purposes (which is not and will not be the case in reality), the GHG emission predications provided in **Tables 6.40** and **6.41** can be considered highly conservative. The intention of LMCC to implement an alternative waste treatment facility within the Lake Macquarie LGA before 2032 is expected to further increase the amount of waste diverted from landfill and hence reduce annual emission rates and extend the lifetime of the AWMF landfill beyond 2032.

Table 6.43: Total Predicted GHG Emissions over the 90 year period 2011 - 2100*

Scenario			1: Existing Landfill			2: Existing Landfill with Expansion		
Remaining Operational Lifetime			2011 – 2014			2011 - 2032		
Emissions Source	Quantity	Units	Total GHG Emissions (T CO_2-e)		Total GHG Emissions (T CO_2-e) for the 90 Year Period	Total GHG Emissions (T CO_2-e)		Total GHG Emissions (T CO_2-e) for the 90 Year Period
			Scope 1	Scope 2		Scope 1	Scope 2	
Fuel Combustion for Equipment on Site								
Scenario 1: Diesel Oil	144	kL / yr	1,557	-	1,557	-	-	-
Scenario 2: Diesel Oil	148	kL / yr	-	-	-	8,802	-	8,802
Scenario 1 and 2: Unleaded Gasoline	0.4	kL / yr	4	-	4	21	-	21
Landfill Gases - Calculated using the NGER Solid Waste Calculator Version 6.1								
Scenario 1: Landfill Methane Emissions	425,741	Total T of waste predicted to be deposited from 2011 to end of 2014 [Total emissions to 2100]	1,583,274	-	1,583,274	-	-	-
Scenario 2: Landfill Methane Emissions	2,639,033	Total T of waste predicted to be deposited from 2011 to end of 2032 [Total emissions to 2100]	-	-	-	3,200,669	-	3,200,669
Electricity Generation								
Scenario 1: Electricity Used on Site	24,341	kWh / yr	-	88	88	-	-	-
Scenario 2: Electricity Used on Site	48,682	kWh / yr	-	-	-	-	964	964
TOTAL T CO_2-e for the 90 year period 2011 to 2100					**1,584,923**			**3,210,456**

* See **Appendix O** for assumptions and site-specific data used in GHG emission calculations

Table 6.44: Average Annual Predicted GHG Emissions over the 90 Year Period 2011 - 2100*

Scenario			1: Existing Landfill			2: Existing Landfill with Expansion		
Remaining Operational Lifetime			2011 - 2014			2011 - 2032		
Emissions Source	Quantity	Units	Annual GHG Emissions ($T CO_2$-e)		Total Annual GHG Emissions ($T CO_2$-e) over the 90 Year Period	Annual GHG Emissions ($T CO_2$-e)		Total Annual GHG Emissions ($T CO_2$-e) over the 90 Year Period
			Scope 1	Scope 2		Scope 1	Scope 2	
Fuel Combustion for Equipment on Site								
Scenario 1: Diesel Oil	144	kL / yr	389	-	389	-	-	-
Scenario 2: Diesel Oil	148	kL / yr	-	-	-	400	-	400
Scenario 1 and 2: Unleaded Gasoline	0.4	kL / yr	0.95	-	0.95	0.95	-	0.95
Landfill Gases - Calculated using the NGER Solid Waste Calculator Version 6.1								
Scenario 1: Landfill Methane Emissions	106,435	Average T / yr of waste predicted to be deposited from 2011 to end of 2014 [Average emissions to 2100]	17,592	-	17,592	-	-	-
Scenario 2: Landfill Methane Emissions	119,956	Average T / yr of waste predicted to be deposited from 2011 to end of 2032 [Average emissions to 2100]	-	-	-	35,563	-	35,563
Electricity Generation								
Scenario 1: Electricity Used on Site	24,341	kWh / yr	-	22	22	-	-	-
Scenario 2: Electricity Used on Site	48,682	kWh / yr	-	-	-	-	44	44
TOTAL AVERAGE ANNUAL T CO_2-e over the 90 year period 2011 to 2100					**18,004**			**36,008**

* See **Appendix O** for assumptions and site-specific data used in GHG emission calculations

6.10.3 Potential Impacts

The expansion of the existing landfill site to include additional cells will result in an increase in the landfill's capacity, which will result in more waste being deposited at the site over an extended period of time (2014 to 2032). This will subsequently result in an increase in GHG emissions produced by the site as the capacity increases, as shown in **Tables 6.40** and **6.41**.The increase in the volume of waste that will be able to be deposited at the landfill and the increased operational lifetime of the landfill are the two most significant factors that will lead to an increase in GHG emissions from the site in the future. GHG emissions due to the additional facilities (such as the additional reuse centre and waste transfer station) at the AWMF are negligible in comparison to the GHGs produced by the decomposing waste in the landfill.

Table 6.44 indicates that predicted annual GHG emissions over the 90 year period (2011 – 2100) will be double the current annual GHG emissions emitted from the landfill. However, the additional deposited waste, which is the primary producer of GHG emissions from the landfill, would produce corresponding GHG emissions regardless of which landfill it was deposited at; hence this increase in emissions will occur at whichever site the waste is deposited at.

It is noted that as previously discussed, the calculations do not take into account the positive impact on GHG emissions that planned future activities to divert some reusable and recyclable waste will have. This includes the proposed diversion of green waste away from the AWMF landfill by the additional reuse centre and relocated green waste processing area, and an AWT facility in the future on Lot 373, hence the calculations are considered highly conservative.

6.10.4 Mitigation Measures

The additional waste which will be able to be deposited at the AWMF due to the expansion of the site would produce a corresponding increase in GHG emissions regardless of which landfill it was deposited at. Therefore in order to minimise GHG emissions produced by the expanded landfill sustainable practices need to be implemented regarding waste diversion and energy use at the AWMF.

Sustainable waste practices include diverting increasing amounts of reusable and recyclable material from landfill and sending them to appropriate reuse and recycling facilities, to reduce unnecessary waste to landfill. This practice would also help to extend the operational lifetime of the landfill. The proposed additional reuse centre will allow for increased diversion of reusable and recyclable material, successfully diverting this waste from landfill.

Other means to reduce GHG emissions from the site include increasing the potential for landfill gas harvesting and electricity generation on site. As gas capture capacity is increased this will also allow more electricity to be fed back into the grid, in essence reducing and offsetting scope 2 GHG emissions. Additional landfill gas monitoring wells would also be installed at the AWMF site to meet the monitoring requirements of the EPL (Licence No. 5873).

The design measures which will be employed to capture landfill gas from the existing waste mass and the waste in the new waste cells are described in detail in **Appendix Q,** and differ slightly in each of three areas of the landfill as follows:

Landfill gas collection outside the footprint of the Piggy Back Liner (PBL), or above the PBL will be managed in accordance with the existing approach described in Section 6.10.2. A system of vertical and/or horizontal LFG Wells are/will be installed, in this area and collected LFG will be directed to the existing Engine (or other treatment technology as required i.e. additional LFG Engine(s) and/or Flare(s) for treatment.

LFG Management in waste landfilled below the PBL presents more of a technical challenge than control of LFG generated above or outside of the footprint of the PBL due to the requirement to collect the gas without compromising the integrity of the PBL. These technical challenges are described in Section 3.3.1 of **Appendix Q**. There are however a number of possible approaches to collecting LFG generated beneath the PBL whilst ensuring the integrity of the PBL is not compromised. These include:

- Specifically designing vertical and/or horizontal LFG Wells and associated interconnecting pipework with consideration to the presence of the PBL;
- Installing vertical LFG Wells through the PBL as the PBL is constructed and fitting sliding “boots” around these penetrations that can move up/down around the LFG Wells as the waste mass settles/moves;
- Increase the number/spacing of LFG Wells located immediately adjacent to the PBL footprint where this is possible;
- Design and install the PBL with engineered passive “Gas Flaps” which would allow LFG to move vertically from beneath the PBL to above the PBL;
- Design and install a LFG drainage layer (i.e. a gravel/aggregate layer) immediately beneath the PBL with appropriate vertical connection risers;
- A combination of some or all of the above.

The adequate control of LFG generated beneath a PBL is a technically complex issue and all of the possible approaches identified above come with their own advantages and disadvantages. GHD **(Appendix Q)** consider that with appropriate design, installation and operation, one or a combination of the approaches identified above are likely to enable LFG generated beneath the PBL to be adequately collected and subsequently directed to an appropriate LFG treatment technology (i.e. an Engine and/or Flare).

Prior to the commencement of the proposed works, LMCC will review the design of the final landfill gas management infrastructure to ensure that it meets the objective of capturing the majority of the gases from the landfill emplacement.

Due to the expansion of gas extraction infrastructure (which is already present) into new landfill areas on a progressive basis, the overall capacity for capturing gas to generate energy at the site and flaring of gas to and reduce GHG emissions will be increased by the proposed works.

6.11 Traffic and Transport

Traffic modelling was undertaken and results indicate that the proposed additions to the AWMF will have minimal impact on the surrounding road network for both the construction and operational phases.

During the construction phase of the sewer pipeline there will be minor disruptions to traffic movement along the access roads to the AWMF and the WWPS and along Wilton, Wangi and Dorrington Roads in the vicinity of trenching and installation works. Once installation is complete there should be no long term traffic impacts due to this infrastructure during the operational phase

6.11.1 Introduction

The existing traffic situation and the potential impacts of the construction and operational phases of the proposed additions to the AWMF site on traffic movements and volumes were considered in a Traffic Impact Assessment (Cardno, 2011a). The assessment findings have been incorporated into the sections below, including recommendations for mitigation measures to reduce traffic impacts. The full assessment document is provided as **Appendix P**.

Traffic impacts due to the proposed installation of the sewer pipeline are also discussed in the sections below. However, as these impacts will only be temporary and short term in nature they are not considered to be as significant as any long term impacts on traffic movements to/from the AWMF.

6.11.2 Existing Environment

The AWMF is situated on Wilton Road, Awaba. The site operates between 8:00am to 4:00pm seven days per week with the exception of Christmas Day and is available for the public to access under supervision by Council staff. All vehicles are currently permitted to access the tip face including the public. Generally on weekdays commercial use dominates at the site, whilst on weekends where vehicle movements are lower usage is predominantly by the general public. Two machines work full time at the tip face and in total there are seven employees on site. A car park with capacity for 24 vehicles is situated adjacent to the existing weighbridges.

Table 6.45 summarises the existing road network that surrounds the AWMF site, including the roads in which the sewer pipeline will be installed (marked with an asterisk).

Table 6.45: Existing Key Roads

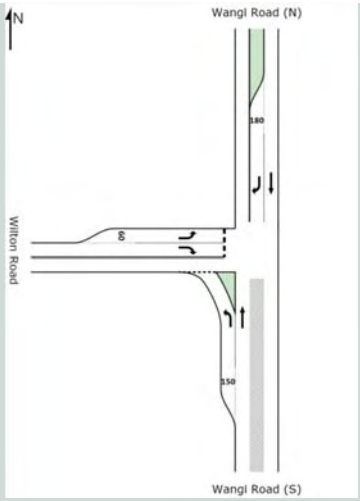
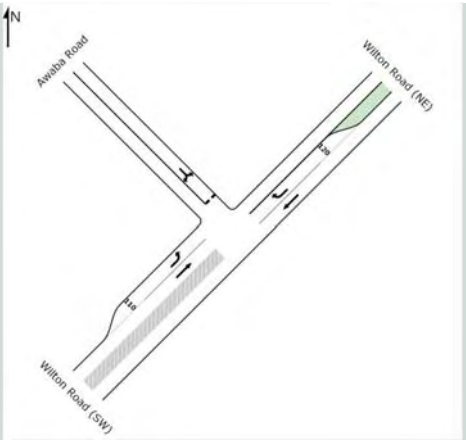
Road Name	Description
Wilton Road*	▪ Collector road with a posted speed limit of 80km/hr; ▪ Links Wangi Road and Awaba Road; ▪ Provides access to the AWMF and the Awaba State Colliery; and ▪ Single carriageway, one lane in each direction, with occasional turning lanes for access into private roads.

Road Name	Description
Wangi Road (MR217)*	▪ State road with a posted speed limit of 80km/hr; ▪ Generally one lane each way with a painted median island separating opposing traffic flows; ▪ Additional turning lanes are provided at intersections; ▪ Significant road upgrade works have been undertaken in recent years; and ▪ Designated B-Double Route.
Awaba Road (MR220)	▪ Two lane road with a posted speed limit of 80km/hr; ▪ Additional turning lanes are provided at intersections; ▪ Provides access to the F3 Freeway via Palmers Road; and ▪ Designated B-Double Route.
AWMF access road (Private Road)*	▪ Provides access to the AWMF; ▪ Width of 10m; and ▪ Divided by a median and has one lane in each direction at the approach to Wilton Road.
Dorrington Road*	▪ Two lane road with a posted speed limit of 80km/hr, which change to 60km/hr approximately 10m beyond the intersection with the access road leading to the WWPS; ▪ Additional turning lanes are provided at some intersections (i.e. for both accesses into the business park); ▪ Provides the primary access from Wangi Road into the suburb of Rathmines; and ▪ Significant road upgrade works have been undertaken in recent years.
WWPS access road*	▪ Provides access to the Rathmines No. 6 WWPS; ▪ Width of approximately 5m; and ▪ A dirt road with a gate at the turn off from Dorrington Road.

* Indicates the sewer pipeline will be installed in the road reserves of these roads.

Table 6.46 outlines existing key intersections that lie within the surrounding road network, including the intersections through which the sewer pipeline will be installed (marked with an asterisk).

Table 6.46: Existing Key Intersections

Intersection	Description	Intersection Diagram (for modelled intersections only)
Wilton Road / Wangi Road*	▪ Priority controlled (i.e. use of signage to control the intersection); ▪ Two approach lanes on the northern leg, including a through lane and a right turn bay and one departure lane; ▪ Two approach lanes on the southern leg, including a through lane and a left slip lane and one departure lane; and ▪ Two approach lanes on the western leg, including a right turn lane and a short left turn lane and one departure lane.	
Wilton Road / AWMF access road*	▪ Priority controlled; ▪ Two approach lanes on the eastern leg, including a through lane and a right turn bay and one departure lane; ▪ One approach lane on the western leg and two departure lanes, including a short acceleration lane for vehicles departing the landfill site; and ▪ One approach lane on landfill site access allowing left and right turn movements.	
Wilton Road / Awaba Road	▪ Priority controlled; ▪ Two approach lanes on the north-eastern leg, including a through lane and a right turn bay and one departure lane; ▪ Two approach lanes on the south-western leg, including a through lane and a short left turn lane and one departure lane; and ▪ One approach lane on the north-western leg and one departure lane.	
Wangi Road / Dorrington Road*	▪ Priority controlled; ▪ Relatively recently upgraded from a seagull intersection to a roundabout; and ▪ One approach lane and one exit lane from all three directions (north and south along Wangi Road and east	N/A

Intersection	Description	Intersection Diagram (for modelled intersections only)
	along Dorrington Road).	
Dorrington Road / WWPS access road*	▪ Not priority controlled; ▪ Left hand turn only into the access road; and ▪ No designated turning lane.	N/A

* Indicates the sewer pipeline will be installed through these intersections.

6.11.2.1 Modelling of Intersection Performance

Analysis of intersection performance was undertaken by Cardno (2011a) for the following three intersections of Wilton Road that may potentially be impacted by altered traffic movements in the long term operational phase of the proposal:

- Wilton Road / Wangi Road;
- Wilton Road / AWMF Access Road; and
- Wilton Road / Awaba Road;

Analysis of intersection performance was undertaken using existing intersection count data and the SIDRA 5.0 software package to determine the following at each intersection:

- Degree of saturation (DoS) – a measure of intersection performance between 0 and 1 that relates to the length of intersection queues and delays in traffic;
- Average delay (AVD) – provides an indication of the length of delay experienced by vehicles at an intersection and is measured in seconds; and
- Level of service (LoS) – related to AVD and uses letters (A to F) as rankings to represent the performance of the intersection (A being a good level of service and F being a poor level of service).

Model outputs are provided in Cardno (2011a) (**Appendix P)**. Results show that the intersection of Wilton Road and Wangi Road currently operates at capacity in the AM and PM peak periods, with delays being experienced by vehicles particularly for the right turn out of Wilton Road onto Wangi Road.

The other key intersections assessed operate within capacity with minimal delays during all three peak periods (AM, midday and PM). Further details are provided in Cardno (2011a) in **Appendix P**.

6.11.2.2 Existing AWMF Traffic Generation

Using a full week of traffic movement data, Cardno (2011a) determined the existing traffic generation of the AWMF. During weekdays, AWMF site traffic generation is generally even throughout the day (average of 21 vehicles/hour), with a peak hour generation between 11:00am and 12:00pm (27 vehicles).

The five day average existing site traffic generation rate was found to be 176 vehicles/day, whilst the seven day average was 169 vehicles/day (Cardno, 2011a). The seven day period includes a weekend, and the average for this period was lower. This correlates with data recorded between 2 February 2011 and 13 February 2011 (provided to Cardno by LMCC's Waste Sites Supervisor) that indicated higher traffic generation rates on weekdays compared to weekends.

6.11.3 Potential Impacts

The results from the traffic modelling undertaken by Cardno (2011a) indicate that the proposed additions to AWMF will have minimal impact on the surrounding road network for both the construction and operational phases.

Potential traffic impacts during installation of the sewer pipeline to the Rathmines No. 6 WWPS are also discussed in this section.

6.11.3.1 Construction Phase

An assessment was undertaken of the future traffic flows at the key intersections in the vicinity of the site with the additional earthworks traffic to/from the AWMF site. Earthworks would be required at certain times to increase the site capacity and prolong the life of the AWMF. It is intended that all excavated material remain on site for future use as daily cover material for the landfill, and this would result in minimal increases in traffic movements during the construction and operational phases due to earthworks.

It is envisaged that when earthworks are required, an additional ten staff will access the site, as well as three additional trucks. It is assumed that the additional traffic will enter the site in the AM peak and exit the site in the PM peak. The traffic modelling results in Cardno (2011a) show that the additional earthworks traffic will have minimal impact on the surrounding road network with no change to the levels of service at the key intersections.

During the construction phase of the sewer pipeline route there will be minor disruptions to traffic movement along the access roads to the AWMF and the WWPS and along Wilton, Wangi and Dorrington Roads in the vicinity of trenching and installation works. Construction vehicles will be accessing the road reserves in these areas and traffic conditions will have to be controlled in the vicinity of works to ensure the safety of site personnel. As discussed in **Section 5.2** the sewer pipeline will be located as follows within the affected roads:

- Along the AWMF access road (within Lot 372) the pipeline will run within the actual roadway corridor to prevent any further disturbance (i.e. within the tarmac/shoulder);
- Along Wilton Road the pipeline will run along the northern side of the road with a maximum impact area of 3m from the edge of the tarmac (i.e. within the road reserve);
- A trenchless crossing will be used under Wangi Road, with the launch pit located in the already disturbed area on the corner of Wilton and Wangi Roads. A maximum impact area of approximately 3m by 2m is anticipated for launch pits on either side of the Wangi Road trenchless crossing within the road reserves;

- Along Wangi Road the pipeline will run along the eastern side of the road with a maximum impact area of 3m from the edge of the tarmac (i.e. within the road reserve);
- Along Dorrington Road the pipeline will run along the northern side of the road with a maximum impact area of 3m from the edge of the tarmac (i.e. within the road reserve); and
- Along the WWPS access road the pipeline will be located within the bounds of the already disturbed dirt access road to the Rathmines No. 6 WWPS.

The most significant traffic impacts along the sewer pipeline route will therefore be during boring under the Wilton/Wangi Road intersection and along the private access road to the AWMF, particularly as this access road will need to continue to be used by waste collection trucks during the construction phase of the project. However, given the short duration of works in these areas, any interruptions to traffic will not be prolonged.

Other potential impacts associated with trenching and installation of the sewer pipeline route, due to the proximity and movement of construction vehicles along local roads along the route, include:

- Incidents/accidents occurring between private and construction vehicles/machinery;
- Incidents/accidents occurring between pedestrians/cyclists and construction vehicles/machinery or private vehicles and site personnel; and
- Periodic disruptions to traffic flow due to construction vehicles and machinery entering and exiting the road reserve areas.

6.11.3.2 Operational Phase

The proposed works will only result in minor, if any, intensification of the AWMF operations as the proposed works are primarily designed to prolong the life of the landfill site. Any minor intensification would be due to additional facilities on the site including the waste transfer station and additional reuse centre. However, these facilities will be handling waste brought to the site rather than amplifying waste volumes that could be brought to the site.

There will be some additional trips generated as a result of the future population increase of the Lake Macquarie LGA, which is expected to be 0.7% per annum. This would result in an increase of 7% for trips made in a ten year horizon. A background growth assumption of 1.5% per annum has been adopted for the surrounding road network. It is expected that only one to two additional staff will be on site during future operations.

An assessment was undertaken of the future traffic flows at the key intersections in the vicinity of the AWMF site, as described in **Section 6.11.2**. The results show that the intersection of Wilton/Wangi Roads will operate at capacity in the AM and PM peak periods under its existing form, with significant delays to vehicles turning right from Wilton Road onto Wangi Road. The intersection will operate with minor delays during the midday peak period. The other key intersections assessed operate within capacity with minimal delays during all three peak periods (AM, midday and PM).

With regards to the sewer pipeline, once installation is complete there should be no long term traffic impacts due to this infrastructure during the operational phase. As excess leachate generated at the AWMF will be piped to the sewer network using this infrastructure, rather than being transported off-site by trucks, additional traffic impacts due to off-site disposal of leachate during the operational phase have also been effectively minimised. The exception to this would be during an incident where the WWPS could not accept the leachate for any reason or if the sewer pipeline became damaged and repairs or maintenance were required (for example to stop a leak). During such incidents any excess leachate would need to be removed from the AWMF site using trucks, which would need to utilise the local road network. However, incidents such as this are expected to be rare and managing the incident would be a priority.

6.11.4 Mitigation Measures

6.11.4.1 Construction Phase

A Construction Traffic Management Plan (CTMP) should be prepared by the Contractor in consultation with LMCC and the Roads and Maritime Services in order to manage construction traffic at both the AWMF site and particularly along the sewer pipeline route. The CTMP should detail vehicle routes, number of trucks, hours of operation, access and parking arrangements and traffic control measures, particularly along the sewer pipeline route.

Adequate traffic control measures should be implemented to manage the movement of construction vehicles and machinery into/out of and within the works areas, to minimise any potential incidents. Control measures should include signage to warn road users of temporarily changed traffic conditions and reduced speed areas near works/workers.

If possible, designated entrances and exits to all works areas should be established for construction vehicles, such that a rumble grid or similar can be implemented at entry/exit points to dislodge any soil/vegetation material from the tyres of equipment leaving the works areas.

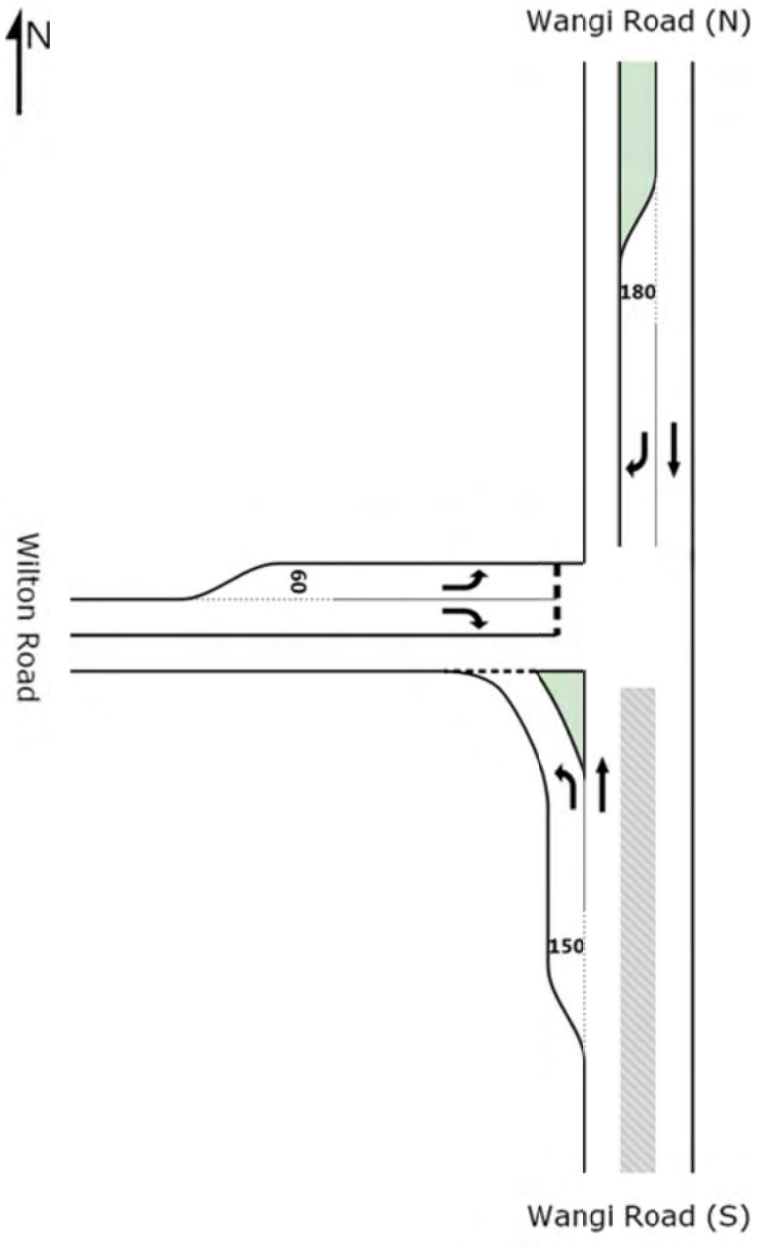
At the completion of installation of the sewer pipeline route vegetation will be reinstated within the road reserves. Any areas within the road reserves or at the AWMF site that have been disturbed by construction vehicles and machinery should be reinstated.

In terms of site access to the AWMF, careful staging of the expansion works at the site would be employed to provide temporary access to the land filling areas during the construction and operational phases to ensure adequate access as each new cell becomes active.

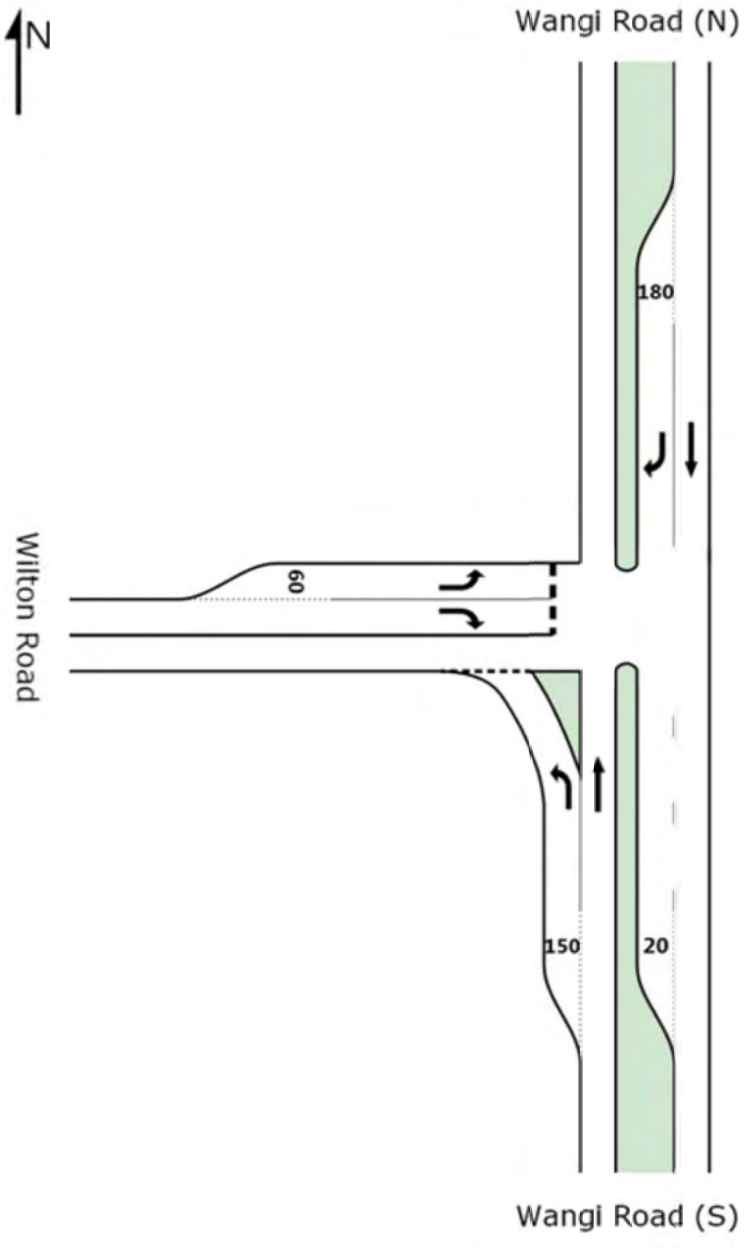
6.11.4.2 Operational Phase

Impacts of the proposed additions to the AWMF on traffic flows and volumes are not anticipated to be a major issue in the operational phase, given the current use of the AWMF site and the nature of the proposal.

In order to appropriately provide for existing traffic volumes at the intersection of Wilton/Wangi Roads and to reduce average delays experienced at the intersection for vehicles turning right onto Wangi Road, it is recommended that the intersection be converted to a seagull intersection at some point in the future, which involves the addition of a turn bay on departure of the southern leg to provide storage space for vehicles turning right from Wilton Road. **Figure 6.30** shows the recommended upgrade layout for the intersection, compared with the existing intersection layout.



Wilton Road and Wangi Road Intersection -
Existing Intersection Layout



Wilton Road and Wangi Road Intersection -
Recommended Intersection Layout

Lake Macquarie City Council

Recommended Intersection Upgrade Layout

ADDITIONS TO AWABA WASTE MANAGEMENT FACILITY ENVIRONMENTAL ASSESSMENT

Legend

180 Lane length (m)

N
W E
S

FIGURE 6.30

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd 2812
Date: 2012-04-26
Coordinate System: GDA 1994 MGA Zone 56
Project: 600308
Map: G6030_IntersectionUpgrade.mxd 02

The recommended intersection upgrade was assessed by Cardno (2011a) and was found to provide additional capacity, as well as safety benefits to vehicles turning right onto Wangi Road. The intersection would operate at a higher level of service in the three peak periods (AM, midday and PM) and would reduce delays to vehicles approaching on Wilton Road, which would assist in improving conditions at this intersection.

With regards to optimising transport links, it is recommended that all transport links should continue to be utilised, due to the minimal route choices to access the AWMF site. However, given the intersection capacity constraints under existing traffic conditions, which will also be the case in the future at the Wilton/Wangi Road intersection for vehicles negotiating a right turn from Wilton Road into Wangi Road, it is recommended that LMCC waste service vehicles be provided with a 'recommended truck route map' to optimise transport links.

Due to the current use of the AWMF site and the nature of the proposal, the impacts of the proposed additions to the AWMF on traffic flows and volumes are not anticipated to be a major impact during the operational phase.

6.12 Hazards and Risks

Due to the scale and nature of the works, it is not anticipated that there would be any major change to the likelihood of occurrence of hazards/risks when compared to the existing environment and existing operations at the site. This reflects the fact that the primary aim of the proposal is to extend existing operations. Additional potential hazard receivers (compared to existing operations) would be located along the road reserves that will contain the sewer pipeline and in the vicinity of the pumping station for the sewer pipeline that will connect to the Rathmines No. 6 WWPS.

6.12.1 Introduction

There are a number of potential hazards or risks that require consideration as a result of the proposed development. Hazards and risks are considered to be substances or events that have the potential to place the local community in danger or cause loss of property or life. Mitigation measures have been recommended to manage the impact of hazards and risks on the environment and the health and safety of people and the community.

A Landfill Environmental Management Plan (LEMP) was prepared by Council (LMCC, 2006) to identify, mitigate and remediate potential environmental hazards and risks at the AWMF site. The sections below draw on the outcomes of the LEMP in the context of the proposed additions at the AWMF site and the proposed sewer pipeline to remove leachate.

6.12.2 Existing Environment

Due to the nature of the AWMF site, a set of inherent environmental hazards and risks are associated with the landfill development that already exists on the site. It is understood that environmental incidents have occurred at the site in the past, including leachate discharge from a holding pond caused by vandalism at the site in 2001. Key potential environmental hazards and risks that may occur at the existing AWMF site include:

- Transportation and depositing of hazardous waste materials onto the site;
- Vandalism of the landfill site (e.g. vandalism of leachate holding ponds, deliberate fires);
- Natural hazards such as geological subsidence or bushfire;
- Fire on site caused by unintentional ignition of flammable wastes or spontaneous combustion of green waste stored on site; and
- Explosion on site caused by landfill gas build-up and unintentional ignition.

The potential impacts from the above hazards include:

- Risk to life and health of personnel and residents in the vicinity of the site;
- Damage to AWMF property and equipment and/or damage to residential properties located nearby;
- Increased risk of spread of fire from the landfill which would act as a fuel source should it be ignited;

- Damage to surrounding bushland habitat and fauna;
- Contamination of soil, surface water and ground water at and within close proximity to the AWMF site; and
- Reduction in the structural integrity of the site.

Under the PoEO Act, the AWMF holds an EPL (No. 5873) for waste disposal (application to land) and composting. A LEMP has been prepared by LMCC (2006) to address compliance under this licence. This LEMP is integral in the identification, mitigation and remediation of potential hazards and risks at the existing site.

Potential hazard receivers are considered to be the local environment, AWMF staff and contractors, waste truck drivers, visitors to the site and residential areas located within a two kilometre radius from the site boundary (the areas of Awaba, Rathmines and Toronto).

6.12.3 Potential Impacts

Due to the scale and nature of the works, it is not anticipated that there would be any major change to the likelihood of occurrence of hazards/risks when compared to the existing environment (i.e. the facilities as they that currently exist at the site). This reflects the fact that the primary aim of the proposal is to extend existing operations. **Table 6.47** summaries the potential changes to hazards/risks associated with the additions to the AWMF and the proposed sewer pipeline.

Table 6.47: Changes to Key Existing Hazards/Risks

Hazard/Risk	Change in Risk due to Proposed Additions
Hazardous waste materials	Unlikely to change at the AWMF site. There is the potential for a spill or leak to occur along the sewer pipeline (due to poor structural integrity, vandalism, etc.) that could result in leachate escaping into the surrounding environment along the pipeline route. Similarly there is the possibility of a fault or system failure at the Rathmines No. 6 WWPS, which could result in leachate escaping into the natural environment surrounding this pumping station.
Vandalism	Unlikely to change at the AWMF site. Vandalism could also occur along the sewer pipeline (although this is considered unlikely as the pipe will be buried underground) and/or at the Rathmines No. 6 WWPS, which could affect the functioning of the pumping station and removal of leachate from the AWMF site.
Natural hazards	Unlikely to change at the AWMF site. Bushfire buffer distances are proposed to be reduced to allow for the proposed additional facilities at the AWMF; however, the width of the perimeter access road will provide sufficient buffer distance (10m) in accordance with RFS guidelines (RFS, 2006). The categorisation of bushfire prone land would be likely to change around the AWMF site boundary with the proposed additions (from Bush Fire Vegetation Category 1, according to LMCC's Bush Fire Prone Land Map dated June 2011, to Bush Fire Vegetation Buffer). The bush fire prone land categorisation of the road reserves that will contain the sewer pipeline is unlikely to change (from Bush Fire Vegetation Buffer and Bush Fire Vegetation Category 1, according to LMCC's Bush Fire Prone Land Map); however, as the sewer pipeline will be installed below the ground surface bush fire impacts on the

Hazard/Risk	Change in Risk due to Proposed Additions
	pipeline are considered minimal.
Unintentional ignition of flammable wastes (fire/explosion)	Unlikely to change at the AWMF site.

It is unlikely that the type or location of potential hazard receivers would be altered by the proposed additions to the AWMF site. Additional potential receivers (in comparison with the existing environment) would be located along the road reserves that will contain the sewer pipeline and in the vicinity of the pumping station for the sewer pipeline that will connect to the Rathmines No. 6 WWPS.

One potential hazard associated with construction works that must be considered is the potential to damage or disrupt existing services during excavation works. GHD undertook a Dial Before You Dig (DBYD) search for services and utilities located within the subject site. The plans provided in **Appendix D** have been designed giving consideration to existing services and utilities.

6.12.4 Mitigation Measures

The proposed development is unlikely to present a significant risk to human health or the environment during the construction or operation phases provided that design principles are upheld, existing management plans continue to be applied, and hazard/risk management controls are appropriately implemented.

Immediately prior to the commencement of construction works the Contractor should undertake an updated DBYD search to ensure existing services and utilities plans are current for the subject site, as plans obtained are generally only valid for a 14 day period. To limit disruption, all underground services and utilities in the vicinity of excavation works should be marked by a qualified marker and exposed by hand prior to excavation by machine. Any services that are accidentally damaged during the works must be repaired or reinstated by the Contractor as soon as possible.

The Awaba LEMP (LMCC, 2006) details a range of procedures to achieve compliance with the EPL (No. 5873) issued for the site. This document therefore contains procedures that currently assist in hazard and risk management at the site. This document should continue to be consulted in the construction and operational phases of the proposed additions to the AWMF.

Table 6.48 provides a summary of the current hazard control measures described in the LEMP with regard to key potential site hazards. Further detail on all hazards is provided in the LEMP.

Table 6.48: **Hazard Control Measures**

Hazard/Risk	Current LEMP Controls

Hazardous waste materials on site	A number of controls are currently implemented to assure the quality of incoming waste. These include:
	▪ Signage at the Wilton Road turn off to the site stating prohibited wastes. Materials that are unacceptable at the facility are:
	  ▪ Industrial Waste that is classified in schedule 1 Part 3 of the PoEO Act;
	  ▪ Hazardous Waste as defined in Schedule 1 Part 3 of the PoEO Act;
	  ▪ Liquid waste as per section 3.1 of the guidelines for Assessment Classification and Management of Liquid and Non-liquid Wastes;
	▪ Refusal of entry of unacceptable waste (if recognised) by the gatehouse operator;
	▪ Video surveillance of all vehicles entering the centre;
	▪ Adequate training and supervision at tip faces to ensure compliance; and
	▪ Metal detectors used at the green waste area to ensure metals are not illegally dumped.
	Waste classification certification is requested prior to disposal for some waste types and is initiated from customer inquiries or through identification of suspect wastes at the waste site.
	Waste screening and sampling is undertaken in accordance with the Awaba Landfill Waste Screening Program. If any unauthorised hazardous waste is found on site, the Newcastle Office of the EPA (OEH) will be notified as soon as practicable.

Vandalism of the landfill site	Council has engaged a private security contractor to ensure the security of the Awaba Landfill Waste Facility outside of operational hours. Security of the facility and equipment is achieved through maintenance of lockable gates, steel mesh fencing, video surveillance and sensor beams.
Natural hazards	The primary natural hazard risk at the site is bushfire. It is understood that a site-specific Fire Management Plan has been developed for the site. The following facilities exist on site for fire fighting: ▪ 12 ML of stored water, connected to two standard fire fighting hydrants; ▪ Fire protection equipment in on site plant (breathing apparatus, fire extinguisher, fire suppressant); ▪ Portable fire extinguishers in the Gatehouse; and ▪ On site plant (compactor, traxcavator). The following control measures are to be taken in the event of a fire: ▪ Ensure the safety of all persons;

Hazard/Risk	Current LEMP Controls
	▪ Contact NSW Fire Brigades and/or Rural Fire Service; ▪ Contact Site Supervisor; and ▪ Assist NSW Fire Brigades and/or Rural Fire Service, as required.
Unintentional ignition of flammable gases/waste (fire/explosion)	Gas accumulation monitoring is conducted monthly and in accordance with LMCC's Awaba Landfill Gas Monitoring Program document. Monthly monitoring of the following is undertaken: ▪ Methane (CH_4); ▪ Carbon Monoxide (CO); ▪ Oxygen (O_2); and ▪ Hydrogen Sulphide (H_2S). Any methane reading which exceeds limits set by environmental guidelines for solid waste landfills are reported to the EPA. Reports on monthly methane concentrations are entered onto a database and are retained on Council's records for at least four years.

A detailed risk review should be undertaken during the detailed design of the proposed additions, and any additional mitigation measures identified as being required should be incorporated into the LEMP. In particular additional mitigation measures for the operation of the sewer pipeline connecting the AWMF to the Rathmines No. 6 WWPS may be required.

It is noted that HWC is responsible for the management of hazards and risks at the Rathmines No. 6 WWPS. Any changes considered to be required to HWC's current operational hazard and risk policies for the pumping station should be made accordingly where required by HWC. LMCC should work with HWC as required to enable the AWMF, pipeline and WWPS risks to be managed in an integrated manner.

6.13 Noise and Vibration

The proposed additions to the AWMF and the sewer pipeline construction are unlikely to have significant impacts on noise or vibration. Potential noise and vibration receivers for the works are situated to the north-west and to the east of the AWMF site, however these receivers are generally located some distance away such that negative impacts would be minor. With regards to the sewer pipeline construction, potential receivers are positioned much closer to the work location, with some residences at Rathmines within 10m of the proposed route. Given this proximity, it is likely that construction noise will be experienced in these locations above the "highly noise affected level". Similarly, vibration effects due to trenching and installation works may be perceptible to users of the Dorrington Road business park and to a few residents occupying properties in Rathmines. However, given the nature of the trenching and installation works, any noise or vibration effects experienced by these occupants are not anticipated to be for an extended period of time in any one location.

6.13.1 Introduction

Noise and vibration from construction and operational activities at a site can impact on inhabitants or visitors to surrounding areas. The sections below examine the existing environment in the context of noise and vibration and consider the potential impacts of construction and operational noise and vibration from the proposed additions to the AWMF on potential receivers. Potential construction noise and vibration impacts on potential receivers during installation of the sewer pipeline are also examined below. Noise calculations have been undertaken using site-specific conditions to assess potential impacts. Mitigation measures have also been recommended to manage noise and vibration at the subject site.

6.13.2 Existing Environment

Observations during a site inspection conducted on 10 February 2011 revealed that the AWMF site has a low-moderate ambient noise level. Noise sources at the AWMF site are generally rubbish trucks and excavators traversing the site. In the wider area surrounding the AWMF site, ambient noise is generally low and is associated with occasional traffic (primarily cars and some trucks) travelling along Wilton Road. Traffic along Wilton Road primarily consists of private vehicles, and trucks entering and exiting the waste facility.

Ambient noise along the sewer pipeline route noise is generally low-moderate and associated with traffic (primarily cars and some trucks) travelling along Wilton, Wangi and Dorrington Roads. Intermittent noise sources are from trucks using the Newstan-Eraring Private Coal Road and trains (especially freight trains) using the Newcastle-Central Coast railway line which both run in a north-east south-west direction to the west of the AWMF site. Vibration was not observed during the site inspection. Existing traffic movements and volumes are described in more detail in **Section 6.11**.

Table 6.49 outlines the key land use zonings of the AWMF site and surrounds, including the roads along the sewer pipeline route, in the context of the Lake Macquarie LEP 2004. This provides some context for the assessment of potential noise impacts on the surrounding environment.

Table 6.49: Key Land Use Zonings

Location	LEP 2004 (In Force) Zoning	LEP 2011 (Draft) Zoning
AWMF site	9 – Natural Resources	SP1 – Infrastructure (Waste or Resource Management Facility)
Surrounding bushland around AWMF site	9 – Natural Resources 7(2) – Conservation (Secondary)	E2 – Environmental Conservation
Awaba village	2(1) Residential Zone	R2 – Low Density Residential
Wilton Road and immediate surrounds	9 – Natural Resources 7(2) – Conservation (Secondary) 5 – Infrastructure	E2 – Environmental Conservation SP2 – Infrastructure
Wangi Road and immediate surrounds	5 – Infrastructure 6(2) – Tourism and Recreation 7(2) – Conservation (Secondary)	SP2 – Infrastructure RE2 – Private Recreation E2 – Environmental Conservation RU2 – Rural Landscape
Dorrington Road and immediate surrounds	6(2) – Tourism and Recreation 5 – Infrastructure 4(1) – Industrial (Core) 10 – Investigation Zone (Employment / Conservation) 7(2) – Conservation (Secondary)	RE2 – Private Recreation SP2 – Infrastructure IN2 – Light Industrial RU6 – Rural Transition E2 – Environmental Conservation
WWPS and immediate surrounds	5 – Infrastructure 7(1) Conservation (Primary) 7(5) – Environmental (Living)	SP2 – Infrastructure RE2 – Private Recreation RU6 – Rural Transition E2 – Environmental Conservation E4 – Environmental Living

It should also be noted that the AWMF site has an existing EPL (Licence No. 5873) that includes conditions relating to acoustic impacts (LMCC, 2010).

6.13.3 Potential Impacts

6.13.3.1 Construction Noise Sources

OEH is responsible for the regulation of noise related issues, primarily through the enforcement of requirements outlined in the PoEO Act.

Sources of noise during the construction phase would include excavators and other heavy vehicles used to transport materials. Plant and equipment noise levels can be described in two ways: sound power level (L_w) or sound pressure level at a given distance (L_p). DECC (2008d) sets out ranges of indicative sound power levels (at source) for a variety of machinery. **Table 6.50** provides an indication of noise levels associated with typical equipment likely be used during the proposed construction works.

Table 6.50: Noise Levels for Various Equipment Types (DECC, 2008d)

Equipment Type	Sound Power Levels (at source) in dB(A)
Jackhammer	121
Rock-breaker	118
Excavator	97-117
Concrete pump truck	103-113
Asphalt paver	103-112
Vibratory roller	103-112
Truck	107

DECC (2009b) stipulates a noise guideline of 75 dB(A) which equates to the "highly noise affected" management level for construction noise received at residences. The "highly noise affected" level represents the point above which there may be strong community reaction to noise. As indicated by the above list of equipment, maximum noise levels at the subject site during construction may be higher than 75 dB(A) if a rock-breaker or jack hammer is used. However, due to the distance of sensitive receivers from the AWMF, overall construction noise at the AWMF site is likely to result in noise under 75 dB(A) at sensitive receiver locations.

Trenching works for the sewer pipeline will most likely be undertaken using a small to medium size excavator and may require rock-breaking equipment if rock substrate is encountered along the route.

In general, duration of machinery operation significantly affects the impact of noise on the surrounding environment. Noise receivers are often particularly sensitive to loud and continuous noise (e.g. excavator) but may also be sensitive to intermittent but annoying noises (e.g. truck reversing beep).

The level of noise impact is highly dependent on the type and proximity of sensitive noise receivers, as discussed below.

6.13.3.2 Construction Noise Receivers

There will be some intermittent noise and vibration emissions from the proposed works during the construction phase.

However, the AWMF site lies on undulating terrain, with several ridgelines and valleys, and these topographic features are likely to provide a significant buffer between the AWMF site and potential noise receivers in both the construction and operational phases. The AWMF site is also surrounded by dense, natural vegetation which may serve to attenuate some noise pollution.

Potential noise receivers for works at the AWMF site were investigated and were found to be situated mainly to the north-west and to the east of the AWMF site. Potential noise receivers for the sewer pipeline installation works varied, with the key features immediately surrounding the works route being the Toronto Country Club/Golf Course and the Dorrington Road business park. A summary is provided in **Table 6.51**.

Table 6.51: Potential Noise Receivers of Proposed Works

Suburb / Feature	Approximate Direction and Minimum Distance from Works	Land Use
For Proposed Works at the AWMF Site		
Awaba	North west, 800m	Residential, Industrial and Infrastructure
Awaba	South east, 950m	Recreation (Lake Macquarie Clay Pigeon Gun Club)
Toronto	East, 1.1km	Residential
Rathmines	South east, 1.2km	Recreation (Toronto Country Club/Golf Course), Industrial/Commercial
Kilaben Bay	East, 1.7km	Residential
Rathmines	South east, 2.5km	Residential
Balmoral	South east, 3.2km	Residential
For Proposed Works along the Sewer Pipeline Route		
Toronto Country Club/Golf Course	Borders the east of Wangi Road and north of part of Dorrington Road, 10m	Recreation
Dorrington Road business park, Rathmines	South of Dorrington Road (opposite the Golf Course), 70m	Industrial/Commercial
Rathmines (residences)	East of access road to WWPS, 10m	Residential (located in Zone 7(5))

Proposed Works at the AWMF Site

For the proposed works at the AWMF site, considering the land uses and distances in **Table 6.51**, the closest sensitive receivers are considered to be the residential properties at Awaba (800m), and Toronto (1.1km). These receivers may be impacted by construction noise generated by excavation and other machinery. The presence of additional heavy vehicles in the vicinity of the works may also impact on receivers, especially those residential properties on Wilton Road, Awaba, because this road represents the only access road to the site of proposed works and forms a link to the Sydney-Newcastle Freeway (F3).

Sound power levels decrease with increasing distance from the source. Noise calculations were carried out for the AWMF site based on various equipment types at the distances described in **Table 6.51**. **Table 6.52** provides a summary of the calculation results. Calculations were undertaken using a straight-line, hemispherical approach for each prescribed distance. Given the topography, dense vegetation and land uses surrounding the AWMF site, these noise calculations are likely to be highly conservative, as these landscape features would provide a substantial buffer between the site and sensitive receivers.

Table 6.52: Calculated Maximum Received Noise Levels for Different Equipment Used at the AWMF Site

Distance from AWMF Site	Equipment Type – Maximum Received Noise Level at Receptor Facade (dB(A))*					
	Jackhammer	Rock-breaker	Excavator	Concrete pump truck	Asphalt paver/ Vibratory roller	Truck
800m	58	55	54	50	49	44
950m	56	53	52	48	47	42
1.1km	55	52	51	47	46	41
1.2km	54	51	50	46	45	40
1.7km	51	48	47	43	42	37
2.5km	48	45	44	40	39	34
3.2km	46	43	42	38	37	32

*Straight-line, hemispherical noise calculations were undertaken to determine Maximum Received Noise Levels at building facades. Due to topography, dense vegetation and land uses surrounding the AWMF site (which are likely to act as noise buffers) and considering calculations were based on the upper limit provided in any range of values (i.e. for large size equipment that might not be used during the proposed works) these values are likely to be highly conservative.

The likely maximum sound level generated at the AWMF site would be approximately 121 dB(A) as a result of any jackhammer operations. **Table 6.52** shows that any jackhammer operations at the AWMF site would produce a maximum received noise level of approximately 58 dB(A) at the facade of residences at the closest receiver distance (800m). **Table 6.52** also demonstrates that noise levels decrease with increasing distance from the AWMF site. These values are well below the "highly noise affected level" of 75 dB(A) prescribed by the DECC (2009b) guidelines for construction noise received at residences.

Given the topographic and land use characteristics and the vegetation buffer surrounding the AWMF site, noise is not anticipated to have significant impacts on local potential receivers.

Proposed Works along the Sewer Pipeline Route

For the proposed works along the sewer pipeline route, considering the land uses and distances in **Table 6.51**, the most sensitive receivers are likely to be the few residential properties at Rathmines located in close proximity to the access road to the WWPS.

These receivers may be impacted by construction noise generated by excavation / trenching works and other machinery, particularly if rock-breaking equipment is required.

Noise calculations were carried out for the sensitive receptors located along the sewer pipeline route based on various equipment types at the distances described in **Table 6.51** using the methodology described above. **Table 6.53** provides a summary of the calculation results, although given the vegetation within the road reserves will likely act as a partial noise buffer these noise calculations are likely to be highly conservative.

Table 6.53: Calculated Maximum Received Noise Levels for Different Equipment Used Along the Sewer Pipeline Route

Distance from Sewer Pipeline Route	Equipment Type – Maximum Received Noise Level at Receptor Facade (dB(A)*					
	Jackhammer	Rock-breaker	Excavator	Concrete pump truck	Asphalt paver/ Vibratory roller	Truck
10m	96	93	92	88	87	82
30m	86	83	82	78	77	72
50m	82	79	78	74	73	68
70m	79	76	75	71	70	65
90m	77	74	73	69	68	63
110m	75	72	71	67	66	61

*Straight-line, hemispherical noise calculations were undertaken to determine Maximum Received Noise Levels. Due to vegetation within the road reserves (which will likely act as a partial noise buffer) and considering calculations were based on the upper limit provided in any range of values (i.e. for large size equipment that is not likely to be necessary considering the scale of the proposed trenching works) these values are likely to be highly conservative.

The likely maximum noise level generated by the sewer pipeline works would be approximately 121 dB(A) or 120 dB(A) as a result of any jackhammer or rock-breaker operations, respectively, **Table 6.53** shows that any jackhammer or rock-breaker operations within 10m of a sensitive receiver along the pipeline route would produce a maximum received noise level of 96 dB(A) or 93 dB(A), respectively, at the facades of residences. This may occur near the access road to the WWPS at the closest receiver distance (10m). These values are well above the “highly noise affected level” of 75 dB(A) prescribed by the DECC (2009b) guidelines for construction noise received at residences. Noise levels received by users of the Toronto Golf Course are likely to be less than calculated in **Table 6.53** at 10m distance from the works due to the lack of facade / open space area, although they will likely still be above 75 dB(A).

However, construction noise at the levels shown in **Table 6.53** should not be experienced for extended periods of time at any one location as trenching and installation works should proceed along the pipeline route relatively quickly.

Table 6.53 also demonstrates that noise levels decrease with increasing distance from the sewer pipeline route, such that receivers over 110m from pipeline works within the road reserves should not be experiencing noise above the "highly noise affected level" of 75 dB(A).

6.13.3.3 Operational Noise

Given the nature of the proposed additions to AWMF and their extent, it is anticipated that there will be no significant, long term noise impacts generated by the proposed additions to the AWMF site during the operational phase. Nor will there be any long term noise impacts due to the proposed sewer pipeline during the operational phase.

The proposed additions to AWMF will only result in very minor intensification of noise at the site, due to additional facilities such as the waste transfer station and additional reuse centre, and as such the proposed additions will primarily result in prolonging the usage of the landfill. As such, variations to current site operations as a result of the project are not likely to be significant in terms of noise impacts. Straight line distances to receivers from the AWMF site are relatively high, with the closest sensitive receivers being located approximately 800m from the site (**Table 6.50**). The distance to potential receivers, in addition to prominent landscape features such as topography and surrounding vegetation, is likely to provide the necessary buffers to mitigate the impacts of operational noise emissions from the site.

6.13.3.4 Construction Vibration Sources

Guidelines for vibration are set out in *Assessing Vibration: a Technical Guideline* (DEC, 2006a). Vibration is generally classified as one of three types (DEC, 2006a):

- Continuous – uninterrupted vibration that continues for a defined period (usually throughout daytime and/or night-time). Examples include machinery and steady road traffic;
- Impulsive – a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). Examples include occasional dropping of heavy equipment and occasional loading/unloading; and
- Intermittent – interrupted periods of continuous vibration (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. Examples include trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving and jackhammers.

6.13.3.5 Construction Vibration Receivers

The effects of construction vibration can be divided into the following categories:

- Those in which the occupants or users of the building are inconvenienced;
- Those in which the integrity of the building or the structure itself may be prejudiced; and
- Those where the building contents may be affected.

Vibration impacts are generally only experienced in locations that are proximal to the site of works (e.g. closer than 200m). With regards to proposed works at the AWMF site, given the distances to potential receptors described in **Table 6.50**, it is unlikely that any of the above vibration effects will be experienced by surrounding potential receivers.

With regards to the sewer pipeline route, given the proximity of potential receptors described in **Table 6.50**, it is considered that vibration effects due to trenching and installation works may be perceptible to users of the Dorrington Road business park and to the few residents occupying properties in close proximity to the access road to the Rathmines No. 6 WWPS. However, given the nature of the trenching and installation works any vibration effects experienced by these users / occupants are not anticipated to be for an extended period of time in any one location. Also, given the relatively small scale of vibration-inducing machinery that will be used within the road reserves due to the confined nature of the works site, vibration effects are not anticipated to be significant or prolonged enough to affect the integrity of any surrounding buildings or structures. As such, although vibration impacts may temporarily be a nuisance to close receptors, they are not considered to be prolonged or significant.

It is also anticipated that there will be minimal increases in traffic movements during the construction phase of the works compared with current traffic volumes (**Section 6.11**), and as such vibration impacts due to increased construction traffic movements are not expected to be significant.

6.13.3.6 Operational Vibration

Considering that sources of vibration are primarily associated with construction machinery, and considering the nature of the proposed works (i.e. an expanded landfill facility with additional features and a sewer pipeline that are unlikely to cause vibration) it is anticipated that operational vibration impacts will be negligible. It is anticipated that there will be minimal increases in traffic movements during the operational phase of the works (**Section 6.11**), and as such vibration impacts are not expected to be an issue during the operational phase of the proposed works.

6.13.4 Mitigation Measures

6.13.4.1 Construction Phase – Noise

Due to the relatively large distances between the AWMF site and the closest residential receivers, no specific mitigation measures are considered to be required for works at the AWMF site, however best practice noise management measures should still be employed.

Guidelines to manage the impacts of construction-related noise are set out in the *Interim Construction Noise Guideline* (DECC, 2009b). During construction of the proposed works, noise mitigation measures should be employed to minimise the daytime and night-time impacts of construction-related noise.

Table 6.54 provides an overview of techniques that should be employed to mitigate the impacts of noise on surrounding receivers. These measures should be incorporated into a noise management plan which should be followed during works to install the sewer pipeline.

Table 6.54: Noise Mitigation Measures (DECC, 2009b)

Mitigation Measure	Details
Prepare and implement a Construction Noise and Vibration Management Plan (if required by the determining authority)	If required, a Construction Noise and Vibration Management Plan should be developed by the Contractor as part of the CEMP prior to the commencement of the proposed works to address issues associated with construction noise and vibration.
Notify the community	LMCC should communicate with the affected residents before the commencement of works to clearly explain proposed construction stages, times, duration and level of noise/vibration associated with the works and provide notification of any proposed respite periods.

Operate machinery in a quiet and efficient manner	▪ Examine quieter alternatives to proposed equipment (e.g. electric equipment instead of diesel/petrol powered);
	▪ Schedule activities to minimise noise impacts. Recommended standard hours for construction work are:
	  ▪ Monday to Friday 7am to 6pm;
	  ▪ Saturday 8am to 1pm; and
	  ▪ No work on Sundays or public holidays.
	▪ Maintain equipment and repair/replace excessively noisy equipment;
	▪ Restrict areas in which equipment can operate to provide as much distance as possible between the site and sensitive noise receivers;
	▪ Use new reversing alarms that have less of a noise impact;
	▪ Coordinate operations such that reversing on site is minimised; and
	▪ Utilise stockpiles, temporary site buildings and other structures to maximise noise shielding.

Involve workers in minimising noise	All reasonable and feasible measures should be taken to minimise construction noise during the works. Avoid dropping materials from a height and dragging heavy materials along the ground.
Set up a complaints register and manage complaints accordingly	A complaints register should be established as part of the CEMP and made accessible to OEH and the local community on request. All complaints should be documented and investigated. LMCC should ensure that there are systems in place to respond to and resolve any issues raised. Further monitoring and mitigation measures may be required following the investigation of a complaint.

Primarily due to the short duration of the works in any one location, more stringent mitigation measures, such as the relocation of sensitive receivers, are not likely to be applicable for the proposed works. Further details regarding noise mitigation measures can be found in DECC (2009b).

6.13.4.2 Construction Phase – Vibration

For the proposed works at the AWMF vibration is not anticipated to be a significant issue for surrounding receivers due to the distance of these receivers to the site. There is the potential for nuisance vibration impacts on receptors in close proximity to the sewer pipeline route (i.e. users of the Dorrington Road business park and residents near the access road to the Rathmines No. 6 WWPS).

However, given the short duration of these impacts (i.e. a few days) it is considered preferable to allow the works to proceed without respite periods or other such delays in order to not prolong the period of impact.

There is a possibility that increased traffic along Wilton Road during the construction phase may impact on nearby heritage items (e.g. the former stationmaster's house on Wilton Road to the west of the AWMF). It is not anticipated that any historical buildings will be impacted due to any vibration impacts along the route of the sewer pipeline (see **Figure 6.24**). Vibration can undermine the cosmetic and in some cases, structural integrity of historical buildings, if vibration doses are in excess of preferred values. DEC (2006a) prescribes the acceptable vibration dose values for intermittent vibration, with a daytime vibration dose of $0.2m/s^{1.75}$ being the preferred value for residences. However, this dose limit is generally set to mitigate impacts on humans rather than vibration impacts on historic buildings and structures.

A vibration complaints register should be established and incorporated into the noise complaints register so that the community have an avenue to respond if any unanticipated impacts are experienced. This should be incorporated within the Noise and Vibration Management Plan to be prepared by the Contractor.

6.13.4.3 Operational Phase

It is anticipated that additional operational noise and vibration impacts will be negligible due to the proposed works. The LEMP (LMCC, 2006) prescribes a number of measures to mitigate operational noise:

- All plant and equipment utilised at the site is maintained in good working order;
- All ridgelines and buffer areas surrounding the site are to be kept in their original condition; and
- All vehicles accessing the site do so along the designated access roads.

The current public access operating hours for the facility are:

- Monday to Friday 8am – 4pm
- Weekend & Public Holidays 8am – 4pm
- Christmas Day Closed

Plant operating hours on the site are:

- Monday to Friday 7:15am – 4:30pm
- Weekend & Public Holidays 7:15am – 4:30pm
- Christmas Day Closed

Occasionally plant may be operated outside these hours on an as needs basis.

The following operational noise mitigation actions form part of the LEMP:

- Continue to monitor noise complaints;

- If noise complaints are issued by the community, engage a contractor to perform a noise assessment on the site; and
- Design and implement a noise monitoring program if required by the recommendations of the noise assessment.

6.14 Cumulative Impacts

Cumulative impacts of the proposed extension to the AWMF could occur as a result of another existing or future planned project proposed within the locality.

The AWMF is located within the West Lake Mine Subsidence District. Other than the Awaba Colliery there are no significant industrial sites in close proximity to the proposal site. As discussed in **Section 6.2.2**, the Awaba Colliery is an underground coal mine operated by Centennial Coal, located approximately 1km west of the existing AWMF.

A search of Planning and Infrastructures' Major Project Register on 21 November 2011 indicated a number of proposed developments within the Lake Macquarie LGA, the majority being either residential subdivisions or coal mining projects. The only proposed development in the vicinity of the AWMF is an extension to Centennial Coal Company Limited mining operations in the local area.

An application for a Part 3A Project Approval was lodged and DGRs were issued in early 2010 by Centennial Coal Company Limited for the Awaba Coal Project, which is seeking approval from the Minister to allow ongoing underground mining and associated surface operations at Awaba Colliery until 2015. This project has been approved. Subsequent to this the Awaba Colliery will be closed as this mine has exhausted its coal resources; however, other mines operated by Centennial Coal Company Limited in the area will continue to operate.

Consultation with the NSW Mine Subsidence Board has indicated that the proposed AWMF landfill cells are underlain by coal seams, which are likely to be mined sometime in the future by Centennial Coal Company Limited, who owns the mining lease (Geotechnique, 2011). It is understood that this mining lease (DA 73-11-98) extends from the AWMF site along Wilton Road to near the intersection between Wilton and Wangi Roads.

The key consideration with the expansion of the Awaba Colliery is mine subsidence. This issue has been discussed in **Section 6.2**. Other than potential for destabilisation of local soils, it is considered unlikely that the impacts of the expanding existing two facilities (landfill and coal mine) will lead to any cumulative environmental impacts that require consideration.

The Oz Mulch composting operations in the suburb of Toronto are currently subject to a development application with LMCC. This composting facility is already operational; however, it is currently unauthorised. The composting operations are located approximately 1.5km directly east of the AWMF site, at the end of Nomad Road, Toronto (off Wangi Road). A potential key cumulative impact of these operations with the proposed AWMF expansion is odour impacts. However, modelling indicated the 99th percentile predicted odour levels from the landfill site will be virtually negligible at the radial distance of 1.5km east of the site in the vicinity of the Oz

Mulch composting operations (PAE Holmes, 2012). Hence the potential for any cumulative odour impacts is negligible.

There are no other known or planned projects in the locality that are anticipated to have cumulative impacts, (including noise, odour, hydrological, ecological or traffic impacts) with the proposed additions to the AWMF. Other than the proposed installation of the sewer pipeline, no known road works are planned in the vicinity of the AWMF site or along the sewer pipeline route at this stage.

A notable project on the Major Project Register within the Lake Macquarie LGA which has recently been approved (determined in September 2011) is the CiviLake Construction and Green Waste Recycling Facility. It is anticipated that this project will interact positively with the current expansion of the AWMF as some recyclable waste will be diverted to this facility in the future, and hence will reduce daily volumes of traffic travelling to the AWMF and further extend the operational lifetime of the AWMF.

LMCC has also recently prepared the Preliminary Environmental Assessment and made an application for a Part 3A Project Approval for an Alternative Waste Treatment (AWT) facility to be located on the adjacent Lot 373, although this project does not yet appear in the list of major projects within the Lake Macquarie LGA (as of 21 November 2011). It is anticipated that this project will also interact with the current expansion of the AWMF as this will provide a key facility to divert a substantial proportion of waste from the AWMF landfill into the future.

7 Environmental Risk Assessment

This chapter details the environmental risk assessment undertaken for the Project. Each risk was considered as part of the environmental assessment and mitigation and management measures were developed where practicable. An overview of the residual environmental risk, following application of mitigation measures is also provided.

7.1 Assessment Methodology

Risk management aims to identify, prevent, contain or reduce negative impacts whilst maximising any opportunities or positive outcomes for the project. For the analysis and management of risk, the following approach has been utilised and is adapted from the AS/NZS Standard for Risk Management ISO 31000:2009 (Standards Australia, 2009).

For each of the areas of consideration, the potential environmental issues are identified and classified as to its probability of occurrence and potential impact on the environment should the risk eventuate. A standard, minor, moderate or major classification is used. This enables focus on those risks most likely to impact the environment and prioritises effort in the development and implementation of preventative and contingent actions.

Having identified the potential risks, it is necessary to determine what event or action may cause that problem. This step is the key to linking potential risks and potential solutions. Each potential risk may have several likely causes. Potential solutions are any preventive actions, which can reduce the probability of impacts occurring, or can reduce the consequence of the impact should it occur.

The decision on whether or not to implement these actions will depend on the particular situation and the associated costs and practicalities. Where a risk cannot be avoided, it is necessary to identify contingent options with an appropriate trigger by which they would be implemented.

Potential environmental risks as a result of the project are outlined in **Section 7.2** and include proposed management strategies to effectively mitigate and manage these risks. The risk level is provided both without (unmitigated risk), and with the management strategy (mitigated or residual risk).

The risk scale adopted is provided in **Table 7.1**. Those risks highlighted in red are considered major risks, those highlight in orange are considered moderate risks, and those highlight in green are considered low risks. The classifications of likelihood and consequence are provided in **Tables 7.2** and **7.3**, respectively.

Table 7.1: Environmental Risk Assessment Matrix

Likelihood / Consequence	L1	L2	L3	L4	L5
C1	Major	Major	Moderate	Moderate	Moderate
C2	Major	Moderate	Moderate	Moderate	Low
C3	Moderate	Moderate	Moderate	Low	Low
C4	Moderate	Moderate	Low	Low	Low
C5	Moderate	Low	Low	Low	Low

Table 7.2: Likelihood of Environmental Risk

Likelihood	Category	Description
L1	Nearly Certain	Expected to occur in most circumstances
L2	Likely	Will probably occur in most circumstances
L3	Possible	May occur at some time
L4	Unlikely	May occur at some time, but is considered unlikely
L5	Rare	Could occur in exceptional circumstances

Table 7.3: Consequence of Environmental Risk

Consequence	Category	Description
C1	Extreme	Major irreversible impact on the environment
C2	Major	Significant impact, long term, potentially irreversible
C3	Moderate	Medium impacts, potential to reverse
C4	Minor	Low impact, localised
C5	Negligible	Insignificant impact

7.2 Risk and Residual Risk Assessment

The analysis of environmental risk for each key issue, as identified in the Director General's Requirements is provided in **Table 7.4**. This also includes details of, or reference to management and mitigation measures and the corresponding residual risk.

Table 7.4: Environment Risk, Mitigation Measures and Residual Risk Assessment

Aspect	Issue	Impact	L	C	Risk	Mitigation / Management	L	C	Residual Risk
Waste Management	Stray litter on site could become airborne during strong winds, leave the site and enter the surrounding environment	Potential to reduce the visual amenity of the surrounding area	L2	C4	Moderate	Landfilled waste will be managed by applying daily cover material over the tip face to prevent litter becoming airborne and potentially leaving the site and undertaking litter patrols at the site, in accordance with existing practices.	L3	C4	Low
Waste Management	The landfill may reach capacity sooner than anticipated if populations or per capita waste rates increase more quickly than assumed	Waste from the local area would have to be sent to an alternative landfill site until alternative local arrangements are made	L4	C2	Moderate	LMCC will implement their Waste Management Strategy to reduce the volume of waste to landfill. This will be done by increasing waste diversion practices and thereby diverting a significant volume of re-usable / recyclable waste from the AWMF landfill, which will act to prolong the life of the expanded landfill	L5	C2	Low
Waste Management	Excess waste generated during construction	Excess waste may be disposed of to landfill where it's more appropriate to reuse / recycle it, unnecessarily filling the landfill	L2	C4	Moderate	LMCC will reuse excavated soil material (likely the largest waste volume generated during construction) for daily cover material during the operation of the landfill, thereby reusing the volume of waste material	L4	C4	Low
Soil and Contamination	Soil erosion and sedimentation during construction	Soils could be carried offsite in runoff into downstream waterbodies	L3	C3	Moderate	An ESCP will be prepared with a number of specified measures in accordance with best practice i.e. use of sediment fences and flow diversion structures, wet down or cover stockpiles, cease construction works in heavy rain, etc.	L4	C3	Low
Soil and Contamination	Slope instability during construction and/or	Could pose health and safety risks and/or structural risks if slopes	L3	C3	Moderate	The CEMP will detail best practice slope stability measures to be followed on site	L4	C3	Low

Aspect	Issue	Impact	L	C	Risk	Mitigation / Management	L	C	Residual Risk
	operation	collapse							
Soil and Contamination	Mine subsidence due to nearby coal mines	Could pose health and safety risks and/or structural risks if mine subsidence occurs in the future	L3	C2	Moderate	Centennial Coal is currently preparing a comprehensive mine subsidence risk assessment in partnership with LMCC, the Mine Subsidence board, GSS Environmental (environmental consultants to Centennial Coal) GHD (Landfill designers), and MSEC (subsidence engineers). Prior to construction, LMCC will consider the results of both this assessment and the existing Geotechnique Report (Appendix F) and undertake a design review to ensure that the final design considers the worst case mine subsidence parameters, and will accommodate the worst case ground movement identified in either document without suffering structural failure or compromising environmental protection.	L3	C4	Low
Soil and Contamination	Unanticipated Contaminated soils may be encountered during construction	Contaminated soils or runoff could be released into the natural environment and downstream waterways	L4	C2	Moderate	The CEMP will Include stop works and actions to follow in the event contaminated land is encountered. Measures to divert and/or capture flows from contaminated areas would be implemented	L4	C3	Low
Soil and Contamination	ASS may be encountered during construction	Acid runoff could be released into the natural environment and downstream waterways or affect infrastructure	L3	C2	Moderate	An ASS Management Plan will be prepared, particularly for the sewer pipeline portion of works. Measures would be implemented to contain any acid runoff produced. Polyethylene will be used to construct the pipeline due to its resistance to corrosion in ASS	L3	C4	Low

Aspect	Issue	Impact	L	C	Risk	Mitigation / Management	L	C	Residual Risk
Soil and Contamination	Saline soils may be encountered during construction	Salinity could damage vegetation and/or infrastructure	L3	C2	Moderate	A Salinity Management Plan will be prepared. Measures in this Plan will aim to minimise the effects of the salinity	L3	C4	Low
Water Quality and Hydrology	Contamination of nearby waterbodies by physical litter from the AWMF landfill	Potential to damage aquatic / riparian species and also impact visual amenity	L3	C3	Moderate	Landfilled waste will be managed using daily cover material to stop any waste items becoming airborne and leaving the site	L4	C3	Low
Water Quality and Hydrology	Contamination of groundwater or stormwater by leachate from the AWMF site	Potential to have negative impacts on aquatic species in nearby waterways	L4	C2	Moderate	All leachate produced will be managed by the leachate collection system such that no leachate escapes into the natural environment under normal operational circumstances. In the event of an incident, additional management measures to contain leachate will be put in place	L5	C2	Low
Water Quality and Hydrology	Contamination of nearby waterways by stormwater from the works areas	Potential to have negative impacts on aquatic species in nearby waterways	L3	C2	Moderate	Surface water diversion and stormwater management infrastructure will be constructed at the AWMF site to manage stormwater, and a *Stormwater Management Plan* will be prepared and implemented to contain site runoff	L4	C2	Low
Leachate	Excessive leachate may be generated if large areas of the landfill are being filled with waste and exposed to rainfall at the same time	Excessive leachate volumes could be generated that may not be manageable using the proposed leachate management system	L1	C2	Major	The expansion of the AWMF landfill will occur in 11 stages such that each stage or cell area is lined, filled with waste and capped in a progressive manner to minimise the volume of uncapped waste exposed to incident rainfall. Leachate management systems have considered the expected rainfall and exposed areas during their design and sizing	L5	C2	Low

Aspect	Issue	Impact	L	C	Risk	Mitigation / Management	L	C	Residual Risk
Leachate	The leachate collection system may be inadequate or fail during operation or the sewer system where leachate is being disposed of may become overloaded or fail	If leachate could not be contained or disposed of to the sewer system it may be discharged to the surrounding environment, causing pollution	L4	C2	Moderate	The leachate management system has been designed in accordance with best practice and has been designed to have adequate capacity to manage expected leachate volumes based on leachate modelling undertaken. Surplus leachate is designed to be pumped off-site to the Rathmines No. 6 WWPS via the proposed sewer pipeline. If the WWPS or sewer system fails pumping of excess leachate off-site will cease. Excess leachate can be temporally trucked / tankered from the AWMF site to avoid the release of polluted water into the natural environment	L5	C2	Low
Flora and Fauna	Areas of native remnant bushland are present on the AWMF site	Vegetation across a 8.55ha impact footprint requires removal at the AWMF site to facilitate the proposed works (7.2ha of which requires biodiversity offsetting)	L1	C2	Major	Proposed offset strategy – BioBanking by LMCC of part of Lot 372, part of the adjacent Lot 373 and another area of suitable land to be determined will generate sufficient Species and Ecosystem Credits to offset the development, and achieve the required improve or maintain outcome for native vegetation communities.	L1	C3	Moderate
Flora and Fauna	There are threatened flora species present on the AWMF site	2,302 *Tetratheca juncea* plants require removal at the AWMF site to facilitate the proposed works	L1	C2	Major	Proposed offset strategy – BioBanking of part of Lot 372 and part of Lot 373 will provide 69,792 Species Credits for *Tetratheca juncea*. This is well in excess of the 33,853 Species Credits required to offset the proposal (Niche, 2012a)	L1	C3	Moderate
Air Quality and Odour	Odour generation	Odour impacts on inhabitants and visitors in	L1	C4	Moderate	Implementation of both a surface and sub-surface gas monitoring program,	L4	C4	Low

Aspect	Issue	Impact	L	C	Risk	Mitigation / Management	L	C	Residual Risk
		the vicinity				covering/capping of waste and establishment of an odour complaints register will help mitigate odour impacts			
Air Quality and Odour	Emissions of NO_2 and other substances	Reduced air quality in the vicinity of the site	L2	C5	Low	Emissions were found to be of acceptable levels in the vicinity; however, standard management practices would be implemented including monitoring and maintenance of power generation unit and flare stack and maintaining plant and equipment on site	L5	C5	Low
Air Quality and Odour	Dust generation	Reduced air quality in the vicinity of the site	L2	C4	Moderate	Implementation of dust mitigation measures described in **Section 6.6.4** will help minimise dust emissions	L3	C4	Low
Aboriginal Heritage	Aboriginal cultural heritage items are present at the AWMF site	Potential damage or displacement of artefacts, items or places that are culturally significant to Aboriginal people could occur	L1	C4	Moderate	Further survey of potentially sensitive archaeological areas in south-western portion of site will be undertaken. Aboriginal Objects could be relocated where possible. A CHMP will be prepared and implemented, along with the mitigation measures described in **Section 0**	L3	C4	Low
Aboriginal Heritage	Aboriginal cultural heritage items are present along the sewer pipeline route	Potential damage or displacement of artefacts, items or places that are culturally significant to Aboriginal people could occur	L1	C4	Moderate	Sub-surface survey of the midden site identified during survey is recommended. Aboriginal Objects could be relocated where possible. A CHMP will be prepared and implemented, along with the mitigation measures described in **Section 0**	L3	C4	Low
Non-Aboriginal Heritage	Non-Aboriginal heritage items are present in the vicinity of the AWMF site and sewer pipeline	Potential damage to heritage building or items could occur from vehicle movements along access	L4	C3	Low	Generation of construction traffic near the heritage items will be avoided, where possible. If any heritage items are impacted stop work immediately and notify	L5	C4	Low

Aspect	Issue	Impact	L	C	Risk	Mitigation / Management	L	C	Residual Risk
	route	roads in the vicinity				OEH. Implementation of mitigation measures described in **Section 6.8.4** will also reduce non-Aboriginal heritage impacts			
Visual Landscape	Change in landscape features	Reduced visual amenity from certain vantage points toward end of landfill life	L1	C3	Moderate	Staged clearing and revegetation of landfill cells will reduce the visual impacts of the expanded AWMF site. Implementation of mitigation measures described in **Section 1.1.1** will also minimise visual impacts	L1	C5	Moderate
Greenhouse Gas	Additional waste will be decomposing in the expanded landfill, which will produce GHGs	An increase in GHG production primarily due to waste decomposing in the expanded landfill	L1	C3	Moderate	The additional GHGs produced by the additional decomposing waste would be equivalent at any site where it was deposited. By implementing energy efficient measures and increasing the capacity to flare and capture landfill gas at the site, these measures will partially offset the increase in GHG production	L1	C4	Moderate
Traffic and Transport	Traffic generation	Minor increases in operational traffic using the AWMF due to growth of the Lake Macquarie LGA, which could further increase traffic issues at the Wilton/Wangi Road intersection	L1	C3	Moderate	Implementation of mitigation measures described in **Section 6.11.4** to reduce short and long term traffic impacts. LMCC waste service vehicles will also be provided with a 'recommended truck route map' to optimise transport links to the AWMF site	L3	C4	Low
Noise and Vibration	Generation of noise and vibration from construction and operation activities	Potentially increased noise levels at sensitive receivers	L2	C3	Moderate	Implementation of noise and vibration mitigation measures described in **Section 6.13.4** will minimise impacts	L4	C5	Low

As shown in **Table 7.4**, with the application of mitigation measures the residual risks associated with the proposed works are all considered to be moderate (four risks), or low (22 risks), with no major residual risks. The residual risks rated as being moderate are:

- Flora and fauna impacts (two risks), which will be offset using the BioBanking scheme;
- Visual impacts of the landfill, noting that the moderate residual risk rating reflects the high likelihood of the expanded site being visible from a number of vantage points, although the consequence of visual impacts are considered to be minor; and
- Greenhouse gas generation, which is an inherent issue with landfilling; however, it will be partially offset through capturing, flaring of the gas and electricity generation at the site.

It is considered unlikely by the project team that any relevant impacts are unknown, unpredictable or irreversible. Known or expected impacts are described in this environmental assessment (including the risk assessment shown in **Table 7.4**).

8 Statement of Commitments

This chapter provides a Statement of Commitments made by LMCC. They detail the environmental management and mitigation measures that will be put in place during the construction and operation of the Project to minimise any identified adverse impacts on the environment, along with other commitments associated with the Project.

This EA identifies a number of environmental management and mitigation measures that should be implemented during the construction and/or operational phases of the proposed works, as detailed in **Table 8.1**. LMCC is committed to ensuring the preparation and implementation of these environmental management plans and mitigation measures for the proposed works, to ensure adverse impacts on the environment due to the works are minimised.

The proposed expansions to the AWMF landfill will be designed in accordance with the NSW Government's *Environmental Guidelines: Solid Waste Landfills* (EPA, 1996). The design will therefore be in accordance with current best practice landfill design and operation. LMCC will ensure that engineering cell design drawings that meet EPA specifications (including the provision of cross sections, cell extension lining, anchoring and capping, leachate collection and disposal system and gas collection system) will be developed as part of the detailed design.

LMCC hold an EPL (Licence No. 5873) for the current operation of the AWMF under the PoEO Act. A review of this licence was recently undertaken and a revised licence was issued on 25 January 2011; however the licence will need to be revised again to incorporate the proposed expansion of and additional facilities at the AWMF.

The Statement of Commitments presented in **Table 8.1** has been prepared based on the environmental risk analysis and impact assessment undertaken as part of this EA. The Statement of Commitments has been prepared in a format that can easily be incorporated into conditions of approval issued by the approval authority.

Table 8.1: Statement of Commitments

Commitments
General
LMCC will undertake the proposed works as described in this EA in accordance with the mitigation and management measures identified in this EA.
LMCC will ensure that a *Construction Environmental Management Plan* (CEMP) is prepared and implemented for the proposed works. The CEMP will detail appropriate mitigation measures for a range of construction activities and will address soil erosion and sediment control, slope stability, uncovering of contaminated, saline and/or acid sulfate soil, spill management, dust suppression, construction noise and vibration (as a minimum).
LMCC will gain all necessary approvals and permits supporting both the construction and operational phases, including: ▪ Updating and obtaining a reissue of the existing EPL (Licence No. 5873) for the site, or obtaining a new

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EPL for the site; and ▪ Obtaining approval under Section 15 if the *Mine Subsidence Compensation Act 1961*.
LMCC will update and continue to apply the existing LEMP for the AWMF to incorporate any new management/mitigation measures and monitoring requirements considered necessary for the proposed works.
LMCC will undertake community consultation as identified in **Section 4.4** during the exhibition period of this EA Report, including holding information sessions for the community and stakeholders.
LMCC will ensure that site monitoring is undertaken in accordance with the existing and future Environmental Protection Licence (EPL) for the site.
Waste Management
LMCC will ensure that during construction the site will be kept clear of unnecessary construction waste. Waste materials generated during the construction phase on both the AWMF site and along the sewer pipeline route will be recycled or reused wherever possible in the first instance.
LMCC will stockpile and reuse soil and vegetation required to be excavated/cleared for the new landfill cells and either reuse these resources as daily cover material for the active tipping face (soil) or process as green waste and use as mulch (vegetation).
LMCC will, wherever practical, place any felled trees or tree limbs in nearby surrounding bushland to act as potential habitat for fauna and reduce the volume of green waste.
LMCC will extend the gas extraction infrastructure into the proposed new landfill Areas A, B and C on a progressive basis into the future so that the capacity for gas capture and energy generation will be enhanced.
LMCC will continue to apply cover material to the active tip face to suppress any litter from becoming airborne during strong winds and escaping into the surrounding environment. LMCC will also continue to undertake litter patrols to manage stray litter.
LMCC will construct the additional facilities at the AWMF out of recycled materials, wherever possible.
LMCC will adopt a phased “three-bin source separated organics” processing system as its preferred waste processing technology for targeting domestic waste, which includes the implementation of a three bin system for domestic use (general rubbish, recycling and garden/food waste).
Soil and Contamination
LMCC will ensure that an *Erosion and Sediment Control Plan* (ESCP) will be prepared and implemented in accordance with the *Managing Urban Stormwater: Soils and Construction Volume 2* series (DECC, 2008a, 2008b and 2008c) prior to works commencing. The ESCP should include a range of measures in accordance with best practice, including but not limited to progressive/staged vegetation clearing, implementation of sediment fences and flow diversion structures, covering or wetting of stockpiles, usage of excavation materials as future daily cover, ceasing of works and checking the integrity of erosion and sediment controls during heavy rainfall, stabilisation of access points and the installation of rumble grids at access points, and rapid backfilling of excavated pipeline trenches.
LMCC will ensure that an *Acid Sulfate Soils Management Plan* must be prepared for the proposed works in accordance with the *Acid Sulfate Soils Manual* (Stone et al., 1998) that will focus on the trenching works for the installation of the sewer pipeline.
LMCC will ensure that a *Salinity Management Plan* will be prepared for the proposed works that will focus on the trenching works for the installation of the sewer pipeline.
LMCC will ensure that a *Contamination Management Plan* is prepared and implemented in the event that contaminated land is encountered during excavation. In such an event, works would cease immediately and OEH would be notified. Emergency measures (such as diversion of surface runoff away from contaminated areas) would also be implemented in a timely fashion.

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Prior to construction, LMCC will consider the existing Geotechnique Report (Appendix F) and the results of the subsidence risk assessment currently being undertaken by Centennial Coal to support an application being prepared to support future mine-workings. (This report is currently being prepared in partnership with LMCC, the Mine Subsidence Board, Centennial Coal, GSS Environmental, GHD and MSEC). LMCC will undertake a design review to ensure that the final design considers the worst case mine subsidence parameters, and will accommodate the worst case ground movement identified in either document without suffering structural failure or compromising environmental protection.
LMCC will facilitate the management of erosion and sediment in the operational phase through stability control measures, utilisation of the proposed wheel was facility, progressive revegetation of capped landfill area and utilisation of the proposed road to minimise surface and vegetation disturbance.
Water Quality and Hydrology
In accordance with the sites EPL, LMCC currently undertakes groundwater quality monitoring using annual or quarterly grab samples at five sites. Parameters monitored include alkalinity (as calcium carbonate), aluminium, ammonia, arsenic, biochemical oxygen demand (BOD), barium, benzene, cadmium, calcium, chloride, chlorinated volatile compounds, chromium (hexavalent), chromium (total), cobalt, conductivity, copper, ethyl benzene, fluoride, iron, lead, magnesium, manganese, mercury, nitrate, organochlorine pesticides, organophosphate pesticides, PCBs, phosphate, polycyclic aromatic , hydrocarbons, potassium, sodium, sulfate, toluene, total phenolics, total dissolved solids, total organic carbon, total petroleum hydrocarbons, zinc, pH. It is expected that the EPL will be amended for the site to account for the proposed site changes, and LMCC will continue to undertake monitoring according to the amended licence conditions. In addition, LMCC propose to install additional groundwater monitoring wells as shown in in **Figure 5.5** to enable improved monitoring of groundwater quality.
LMCC will ensure that, should dewatering of groundwater be required as part of any excavation works, a licence is sought under the *Water Management Act 2000*.
LMCC will ensure that a *Stormwater Management Plan* is prepared and implemented for the construction phase of the proposed works to mitigate the impacts on water quality.
LMCC will ensure that temporary stormwater quantity and quality management measures are implemented during the construction phase, including the installation of silt curtains, hay bale filters and stormwater diversions.
In accordance with the sites EPL, LMCC currently undertakes stormwater quality monitoring using annual or quarterly grab samples at four sites. Parameters monitored include alkalinity (as calcium carbonate), aluminium, ammonia, arsenic, biochemical oxygen demand (BOD), barium, benzene, cadmium, calcium, chloride, chlorinated volatile compounds, chromium (hexavalent), chromium (total), cobalt, conductivity, copper, ethyl benzene, fluoride, iron, lead, magnesium, manganese, mercury, nitrate, organochlorine pesticides, organophosphate pesticides, PCBs, phosphate, polycyclic aromatic hydrocarbons, potassium, sodium, sulfate, toluene, total phenolics, total dissolved solids, total organic carbon, total petroleum hydrocarbons, total suspended solids, zinc and pH. LMCC will ensure that the quality of stormwater leaving the site will be in accordance with the limits outlined by ANZECC (2000) and the existing EPL
LMCC will ensure that a 30m buffer zone will be established from the watercourse centre-line and that all water management measures, both temporary construction phase measures and permanent measures, are located outside of this buffer.
LMCC will ensure that the proposed expansion will incorporate appropriate design principles for leachate basins, including ensuring that basin liners are utilised, active storage depths in the proposed basins are 0.75m from the permanent water level to the level of the primary spillway, and overflows from the basins are conveyed to the outfall(s) via 0.5m deep rock lined channel with base widths of 2m and side slopes of 1(V):2(H).
Leachate
Leachate will be managed in accordance with best practice:

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▪ The entire new landfill area will be lined (implementing a 'piggyback' liner over the existing waste using a LLDPE liner; ▪ Leachate will be collected, treated and managed/disposed of appropriately for the operational lifetime of the landfill; and ▪ The landfilling operations will be carefully staged, with care taken at all times to minimise the inflow of water into active landfill areas.
LMCC will incorporate aeration in the proposed 8ML leachate pond, as discussed in **Section 6.4.4** and determined in consultation with HWC, such that surplus leachate disposed of to the sewer network (via the proposed sewer pipeline) meets HWC's quality requirements. The existing 6ML leachate pond will be retained, and operated in series to provide additional physical treatment.
LMCC will ensure that engineering cell design drawings that meet EPA specifications (including the provision of cross sections, cell extension lining, anchoring and capping, leachate collection and disposal system and gas collection system) will be developed as part of the detailed design. LMCC note that this information is also required as part of the required application to vary the existing EPL (Licence No. 5873) to permit the construction of the cell extension.
LMCC will seek to establish a Trade Wastewater Agreement with HWC for the discharge of leachate from the AWMF site to the HWC sewer system.
LMCC will ensure that a sewer flowmeter is installed, and a sampling point established, at the AWMF package pumping station so that volumes and quality of leachate discharged to the HWC sewer network can be monitored.
LMCC currently undertakes leachate quality monitoring via quarterly grab samples at one location, and this includes testing for alkalinity (as calcium carbonate), ammonia, biochemical oxygen demand (BOD), calcium, chloride, fluoride, iron, magnesium, manganese, nitrate, organochlorine pesticides, potassium, sodium, sulfate, total phenolics, total organic carbon, total petroleum hydrocarbons, total suspended solids and pH. LMCC will ensure that leachate quality monitoring continues in accordance with the conditions of the new EPL to be issued for the site.
Flora and Fauna
LMCC will ensure that a BioBanking Agreement is formalised for the site. LMCC will finalise a *BioBanking Statement* for the Lot 372 Development Site and a *BioBanking Agreement* for the proposed BioBank Site (comprising part of Lot 372, part Lot 373 and an additional suitable area of land (yet to be determined)) to offset the removal of 2,302 *Tetratheca juncea* plants and 7.2ha of native vegetation communities at the site (of a total 8.55ha of vegetation to be impacted). LMCC will make provision for these offset sites to be preserved and managed in-perpetuity.
LMCC will provide DP&I with a *BioBank Site Management Plan* that commits the proposed Awaba BioBank Site to in-perpetuity management and a fund deposit calculated on this basis. The required management actions will be determined in consultation with OEH and can be estimated using Part A of the BioBanking Credit Pricing Spreadsheet (OEH, 2011c)
Upon establishment of the Awaba Biobank Site, LMCC will ensure that 392 Ecosystem Credits of the required vegetation types and 33,853 Tetratheca juncea Species Credits will be retired within the BioBanking Scheme.
LMCC will ensure that a *Vegetation Management Plan* is prepared and implemented prior to commencement of the proposed works that will include details pertaining to procedures for clearing, landscaping and revegetation/rehabilitation works that are planned for the AWMF site during the construction, operational and post-closure phases and also immediately following completion of the installation of the sewer pipeline. The plan will include a *Vegetation Clearing Protocol* and a *Weed Management Sub-Plan*.
LMCC will ensure that a *Fauna Management Plan* is prepared and implemented prior to commencement of the proposed works that will provide a protocol for responding to the detection and relocation of native fauna present in trees, hollows and logs that lie within the proposed areas for clearing. LMCC will ensure that details regarding the most appropriate season(s) to undertake clearing with regard to reducing disturbance to fauna (especially

Commitments
nestlings) are included in addition to details regarding the proposed management of pest species during the proposed works. Where they have been prepared and where applicable, LMCC will consider the details set out in *Recovery Plans*, *Threat Abatement Plans* or *Priority Action Statements* for listed threatened species and incorporate relevant mitigation measures into the *Fauna Management Plan*.
Air Quality and Odour
LMCC will ensure that a *Construction Environmental Management Plan* is prepared and implemented prior to commencement of the proposed works, and that this plan will include management/mitigation procedures for air quality, odour and dust, including minimising the number of stockpiles on site, limiting unnecessary vegetation clearing, and reducing/controlling the number of trips and trip distances where possible.
LMCC will ensure that standard odour management practices for landfill sites will be utilised in the operational phase of the works, including the continuation of current practices such as daily covering/capping of the active tip face, gas monitoring programs and an odour complaints register.
LMCC will ensure that standard air quality management practices for landfill sites will be utilised in the operational phase of the works, including the maintenance of gas collection infrastructure, power generation unit, flare stack, and plant and equipment on site, and a flare stack emission monitoring program.
LMCC will ensure that air quality, odour and dust mitigation measures are implemented during the operational phase of the works, including covering/capping of waste, gas emission monitoring programs, and maintenance of gas infrastructure and site plant/equipment.
LMCC currently undertakes environmental monitoring of methane which includes monthly, in-situ monitoring of %(v/v) methane inside buildings at the site and also on the surface of the landfill. LMCC will ensure that this monitoring continues. Additional gas monitoring locations are proposed as part of the works as shown in in Figure 5.4.
Aboriginal Heritage
LMCC will ensure that a *Cultural Heritage Management Plan* is prepared in partnership with the registered Aboriginal stakeholders and implemented for the construction phase of the proposed works. The CHMP will demonstrate that effective community consultation with local Aboriginal communities has been undertaken during the preparation of the Plan. The CHMP will include procedures for ongoing Aboriginal consultation and involvement, management of all Aboriginal cultural heritage values associated with the project area, the responsibilities of all stakeholders, details of proposed mitigation and management strategies of all sites; including any additional investigation processes, salvage activities, monitoring, etc.; procedures for the identification and management of previously unrecorded sites (excluding human remains), and compliance procedures in the unlikely event that non-compliance with the CHMP is identified.
LMCC will ensure that further archaeological survey around the creek lines at the AWMF site and sub-surface testing of the midden site identified along the pipeline route is undertaken prior to the commencement of construction works to determine the full nature and extent of these archaeologically sensitive areas. These investigations will initially comprise a series of 1m² probes spaced evenly over the area of impact along the creek line, but may be expanded if artefact densities warrant further investigation or salvage. A monitoring and collection program will then be undertaken by the registered Aboriginal stakeholders during all proposed sub-surface excavations to allow collection of any artefacts that may be disturbed in this area (with subsequent relocation and reburial “in country” and in a location that will not be subject to any future impacts).
LMCC will ensure that a minimum buffer of 5m around culturally modified trees to be retained will be delineated and enforced to reduce the impacts on these sites. LMCC will conduct further investigations during the detailed design phase as to whether an increase in the size of the buffer distance around culturally modified trees of the project is achievable given site constraints.
LMCC will provide an opportunity for the Registered Aboriginal Parties (RAPs) to monitor the initial ground disturbance works associated with all sections of the excavations (ground surface impacts) so that any potentially impacted artefacts may be collected by the RAPs.
LMCC will develop and implement an Aboriginal Cultural Heritage Induction Program for all personnel associated

Commitments
with the project, to make them aware of the site's Aboriginal heritage values and artefacts that are to be conserved at the site.
LMCC will ensure that any new Aboriginal artefacts located uncovered due to the development and/or sub-surface excavation or monitoring activities will be recorded and registered with the EPA as part of the assessment process in accordance with the requirements of Section 89A of the NPW Act.
LMCC will ensure that work is ceased immediately in the event that any bone or stone artefacts, discrete distributions of shell or any other objects of potential cultural association are uncovered during earthmoving or other activities, in accordance with the *National Parks and Wildlife Act 1974*, "stop work" provisions.
LMCC will ensure that strategies for the management of Aboriginal sites will be developed in collaboration with the Registered Aboriginal Parties and documented in an Aboriginal Cultural Heritage Management Plan, as recommended by the two Aboriginal Cultural Heritage Assessment Reports (ACHAR).
LMCC will ensure that archaeological excavations of known or Potential Archaeological Deposit/archaeological sensitivity will be conducted (as recommended by the ACHAR) where impacts may result from construction works. The objective of any such excavations will be to confirm whether there is a likelihood of any objects being present (and therefore impacted by the works), and where this is the case to develop appropriate management strategies in collaboration with the Registered Aboriginal Parties and to formalise these in an Aboriginal Cultural Heritage Management Plan.
Non-Aboriginal Heritage
LMCC will ensure that none of the non-Aboriginal heritage items identified in the vicinity of the proposed works will be impacted by the proposed works by making the Contractors aware of the items and ensuring the Contractors avoid them.
Visual Landscape
LMCC will progressively excavate, fill and re-vegetate Areas A and B and subsequently fill and re-vegetate Area C (11 cell areas in total across Areas A, B and C) as shown in the Staging Plan in **Figure 6.9**, which has been developed to minimise the visual impacts of the proposed works.
LMCC will ensure that the application of daily cover to the active tipping face is continued during the construction and operational phases of the works to ensure regular concealment of the landfill emplacement.
LMCC will ensure that revegetation and rehabilitation will be undertaken at the site once the landfill has reached capacity, so that effective concealment of the emplacement will be achieved in the long term.
Greenhouse Gas
LMCC will continue to recover gases produced by the AWMF for energy generation and to minimise GHG emissions from the AWMF landfill. LMCC will increase the potential for landfill gas harvesting and electricity generation on site through the expansion of gas extraction infrastructure at the site.
Prior to the commencement of the proposed works, LMCC will review the design of the final landfill gas management infrastructure to ensure that it meets the objective of capturing the majority of the gases from the landfill emplacement.
LMCC will continue to monitor landfill gases generated for reporting purposes.
Traffic and Transport
LMCC will ensure that a *Construction Traffic Management Plan* is prepared and implemented for the proposed works.
LMCC will ensure that the intersection of Wilton/Wangi Roads is upgraded to appropriately provide for existing traffic volumes and to reduce average delays experienced at the intersection for vehicles turning right onto Wangi Road.

Commitments
Hazards and Risks
LMCC will continue to undertake the procedures detailed in the *Awaba Landfill Environmental Management Plan* (LMCC, 2006) to achieve compliance with the EPL issued for the site.
LMCC will undertake a detailed risk review during the detailed design of the proposed additions, and any additional mitigation measures identified as being required will be incorporated into the *Awaba Landfill Environmental Management Plan*.
LMCC will revise the site-specific *Fire Management Plan* within the *Awaba Landfill Environmental Management Plan* to ensure it remains current considering the proposed works.
LMCC will continue to implement OH&S practices and adhere to relevant OH&S standards to ensure employee and user safety at the AWMF site.
LMCC will work with HWC, as required, to enable the AWMF, pipeline and WWPS risks to be managed in an integrated manner.
Noise and Vibration
LMCC will ensure that a *Noise and Vibration Management Plan* is prepared in accordance with the *Interim Construction Noise Guideline* (DECC, 2009b) and implemented for the construction phase of the proposed works.
LMCC will continue to undertake the procedures detailed in the *Awaba Landfill Environmental Management Plan* (LMCC, 2006) to mitigate operational noise at the site.

9 Conclusions

This chapter provides a summary of the findings of the environmental assessment and gives consideration to the likely residual impacts of the Project in light of the mitigation and management measures proposed.

This EA addresses the requirements set out by the DP&I in the DGRs issued on 3 July 2011. The conclusions of this report are as follows:

- There is an urgent need to provide a suitable waste disposal facility for the Lake Macquarie region, as the current landfill at the AWMF will reach capacity in four years;
- LMCC has investigated alternative options and expansion of the AWMF site rather than creation of a new landfill elsewhere is considered to have the least environmental, social and economic impacts;
- The project will have some environmental impacts, however management measures to mitigate impacts, where they have been identified, have been developed and are specified in this EA to minimise any environmental impacts;
- The most significant impact of the proposed works is considered to be the clearing of native vegetation communities and threatened flora (*Tetratheca juncea*) within the direct footprint of the proposed works. However, this impact will be effectively offset through the provisions of a BioBanking scheme that LMCC has committed to.

It is considered that the proposed additions to the AWMF conform to relevant legislation, in particular Clause 123 of the Infrastructure SEPP.

This EA concludes that overall the proposed additions to the existing AWMF will not have a significant environmental impact, providing mitigation and management measures specified in this report are employed and implemented during construction and operation.

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